PB81-126377

GC/MS Analysis of Ambient Air Aerosols in the Houston, Texas Area

Research Triangle Inst.
Durham, NC

Prepared for

Environmental Sciences Research Lab.
Research Triangle Park, NC

Nov 80

U.S. Department of Commerce
National Technical Information Service
NTIS

EPA-600/2-80-194
November 1980

PB81-126377

GC/MS ANALYSIS OF AMBIENT AIR AEROSOLS IN THE HOUSTON, TEXAS AREA

by

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Contract No. 68-02-2963

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U. S. ENVIRONMENTAL PROTECTION AGENCY
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1. REPORT NO.
EPA-600/2-80-194

2.

3. RECIPIENT'S ACCESSION NO.
PB81 126377

4. TITLE AND SUBTITLE
GC/MS ANALYSIS OF AMBIENT AEROSOLS IN THE HOUSTON, TEXAS AREA

5. REPORT DATE
November 1980 Issuing Date.

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Charles M. Sparacino

8. PERFORMING ORGANIZATION REPORT NO.
RTI/1680/00

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Research Triangle Institute
P.O. Box 12194
Research Triangle Park, NC 27711

10. PROGRAM ELEMENT NO.
C05A1A / 01-0643 (FY-80)

11. CONTRACT/GRANT NO.
68-02-2963

12. SPONSORING AGENCY NAME AND ADDRESS
Environmental Sciences Research Laboratory-RTP, NC
Environmental Research Center
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

13. TYPE OF REPORT AND PERIOD COVERED
Final 8/78 - 12/79

14. SPONSORING AGENCY CODE
EPA/600/09

15. SUPPLEMENTARY NOTES

16. ABSTRACT

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17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution *Aerosols Chemical Analysis *Gas Chromatography *Mass Spectroscopy	Houston, TX	13B 07D 14B

18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

ABSTRACT

Ambient air aerosols and vapor samples were collected by Radian Corp., Austin, TX., in the Houston, Texas area using three different samplers. A High Volume and dichotomous sampler were used for the collection of particulate; vapor-phase organic samples were collected with a resin trap sampler developed by Illinois Institute of Technology Research Institute (IITRI). The Research Triangle Institute (RTI) was responsible for qualitative and quantitative analysis of these samples. Vapors were analyzed by thermal desorption from the resin bed followed by glass capillary gas chromatography/mass spectrometry (GC/MS). Hi-Vol samples were extracted and solvent-partitioned prior to analysis by GC/MS. Dichotomous filters were extracted and the concentrated extracts analyzed directly by GC/MS.

Results showed the presence of many saturated and unsaturated materials in all samples. Vapor-phase organics (IITRI samples) consisted predominantly of hydrocarbons (C_4-C_{15}), alkylated benzenes and some chlorinated compounds. Results from the dichotomous samples indicate insufficient collection of material for comprehensive air analysis. The extracts from Hi-Vol filters contained small quantities of organics. Their analysis was further complicated by the presence of background contaminants, tentatively identified as siloxanes. Quantitative analysis was carried out for selected components from each sample type.

This report was submitted in fulfillment of contract number 68-02-2963 by RTI under the sponsorship of the U. S. Environmental Protection Agency. This report covers the period from August 4, 1978 to November 3, 1979, and work was completed as of December 3, 1979.

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ACKNOWLEDGEMENTS

For sorbent preparation, sample work-up and final analyses, Ms. W. Wilson, Ms. G. McCue and Ms. K. Brady are hereby acknowledged. Mass spectral data was provided by Ms. D. Smith and Dr. K. Tomer. Special assistance in mass spectral interpretation was provided by Ms. N. Castillo. Valuable assistance and advice was obtained throughout the course for the program by Dr. E. Pellizzari.

Mr. R. Stevens, Ms. C. Sawicki and Dr. R. Patterson of EPA are acknowledged for their help in providing information and hardware for the dichotomous and sorbent samplers used in this study. Thanks also are extended to the project officer, Dr. Kenneth Krost.

SECTION 1

INTRODUCTION

The 1977 Clean Air Act Amendments called for EPA research studies in the Gulf Coast area. Priority was given to the problems of aerosol pollutants and Houston, Texas was chosen as the initial study site. The EPA issued a procurement request to obtain gas chromatography/mass spectrometry (GC/MS) evidence on the identity of the organic particulate pollutants present in the atmosphere above Houston and surrounding areas. The purposes of the contract were (a) to obtain evidence that would serve to guide studies of health effects from ambient aerosols and (2) to determine sources/causes of aerosol pollution in the Houston area.

Field sampling was conducted under a separate procurement. Three different samplers were used in this study, Hi-Vol, dichotomous and a filter and adsorbent trap sampler. Filters and sorbent resins were shipped to the Research Triangle Institute (RTI) following field sampling. A total of 23 samples was analyzed: 12 filter and adsorbent trap samples, 5 dichotomous samples and 6 Hi-Vol samples.

SECTION 2

SUMMARY AND CONCLUSIONS

This program was undertaken to analyze, by techniques of GC/MS, ambient air aerosol samples collected in Houston, TX as part of the EPA-ESRL 1978 Houston study on ozone and aerosols. Aerosol samples were collected (under separate contract - Radian Corp.) during September/October 1978 using three different sample collection devices. The samples were shipped to the Research Triangle Institute for work-up and analysis.

The sample collection devices used included Hi-Vol samplers (6 samples), Hi-Vol plus vapor trap samplers (4 samples), and dichotomous samplers (5 samples). All Hi-Vol samplers utilized cleaned quartz fiber filters for sample collection. The vapor traps consisted of a series of tandem sorbent cartridges (12 cartridges) containing Tenax GC located downstream of the Hi-Vol filter. The dichotomous filters (Teflon) analyzed included only the "fine" size filters.

All quartz fiber filters were Soxhlet extracted and the concentrated extracts were solvent partitioned to provide 6 fractions (acids, bases, 4 neutral fractions) for analysis by glass capillary GC/MS. Based on mass spectral information, component identifications were made for each extract. Identification and subsequent quantification of selected components were rendered difficult due to the presence of large amounts and numbers of phthalate esters and organosiloxanes. The analysis of appropriate blanks indicated that these contaminants were associated with the quartz fiber filters used in this study. Of the non-background compounds identified, the vast majority were characterized as saturated hydrocarbons, C_{11}-C_{30}. Esters of diacids (C_3-C_9) and fatty acids (C_{10}-C_{20}), and alkyl phenols (C_9 and C_{10}) constituted the predominant components of the oxygenates. A relatively small proportion of polynuclear aromatics (C_9H_8-$C_{20}H_{12}$) were also identified. Quantitation of selected hydrocarbons

(C_{17}-C_{19}) showed levels of 1-8 ng/m^3. These values are comparable to levels obtained by other investigators and are significantly higher than non-urban values.

The sorbent trap samples were analyzed by thermal desorption of the volatile species, cryofocusing of the components and glass capillary GC/MS. Over 150 compounds were identified from each cartridge, encompassing a boiling point range of ~0-270°. This corresponds to hydrocarbons ranging from butylene to pentadecane. This class of materials, i.e. saturated hydrocarbons accounted for ~60% of all compounds identified. Aromatics, principally alkylbenzenes, comprised 20-25% of the total with oxgenates and halogenated components making up the remainder. The volume of air passed through each cartridge pair was such that the breakthrough volumes of most compounds were exceeded. Quantitative analysis of selected components therefore provided data representing minimum concentration levels of these components. The hydrocarbons (C_6-C_{12}) were present in amounts ranging from 1-10 μg/m^3. Benzene and C_1- and C_2-alkylbenzenes were measured at 1-20 μg/m^3. Trichloroethylene was present in greater amounts than any other halogenated compound, and was quantitated at 1-7 μg/m^3.

Dichotomous samples (Teflon filters) were solvent extracted, and the concentrated extract subjected directly to glass capillary GC/MS. The relatively low quantities of aerosol collected by this sampler produced correspondingly low quantities of aerosol extract. Less than ~30 components were identified from each extract analyzed. As with the Hi-Vol filters, the principal non-background components were identified as saturated hydrocarbons. Quantitation of selected compounds (C_{15}-C_{18}) showed ambient levels of ~7 ng/m^3.

Overall results indicate that the organic component of Houston ambient air aerosol is predominantly saturated hydrocarbons, with lesser but significant amounts of alkyl aromatics and lower molecular weight (C_1-C_2) halogenated hydrocarbons. The levels of these materials are comparable to those found in other urban atmospheres and are significantly higher than those found in non-urban "clean" air. No clear relationship was observed between levels or numbers of components found, and time or location of sampling site.

SECTION 3

RECOMMENDATIONS

The results of this study indicate several areas where further investigations could provide useful results. Specific recommendations include:

(1) Modification of the IITRI sampler. Leakage through fittings and valves was evident from cartridge analysis; redesign should include vacuum-tight valves/fittings. The ease of handling (assembly/disassembly, cleaning, etc.) of the sampler could be improved by construction of an all glass or glass/stainless steel unit.

(2) Further research into the use of the dichotomous sampler for collection and subsequent analysis of aerosol organics. The automated nature of this sampler, its high collection efficiency, sizing capability and use of standard Teflon filters for collection are attractive features that could well be taken advantage of for aerosol organics analysis. Research should be directed toward improving analytical sensitivity to a point that is compatible with the amount of aerosol collected by the dichotomous sampler.

(3) Investigation of source and nature of glass or quartz fiber filter (GFF and QFF, respectively) background contamination. The development of suitable clean-up procedures, and a determination of the precise nature of the contaminants associated with such filters would allow for greater confidence in analytical results obtained from samples collected via GFF or QFF.

(4) Development of methodology for accurate non-methane hydrocarbon determinations. Software development (GC/MS) could provide for the group quantitation of paraffinic hydrocarbons as obtained from the routine analysis of GFF extracts by glass capillary GC/MS/COMP. Such data could thus be available in a reliable and relatively rapid fashion as an adjunct to comprehensive qualitative results from ambient air aerosol analysis.

SECTION 4

OBJECTIVES

This study was designed to provide information relating to the organic aerosol pollutants in the Houston, Texas area. Specifically, the Research Triangle Institute was to perform analysis using GC/MS methods on 16 samples collected by an EPA designated contractor. These 16 samples were to include 5 samples collected with a filter and adsorbing trap (the filter and trap contents to be analyzed separately), 4 samples collected with a dichotomous sampler and 7 samples collected with a "high-volume" sampler. In addition to these chemical analyses, quantitative analysis was to be carried out for selected organic compounds from each sample by GC/MS.

SECTION 5

SAMPLING

The major sampling effort for the Houston air study was provided by Radian Corporation, Austin, Texas under a separate contract. All samples analyzed by RTI were collected by Radian using filter and adsorbent trap, dichotomous or Hi-Vol samplers. In an effort to minimize problems associated with sample medium preparation, shipping and storage of collected samples, labeling procedures, etc., RTI provided input to Radian personnel responsible for field sampling. This input was designed to enhance the compatability of the sampling and analysis procedures and was based on past experience as well as in-house studies pertinent to the sample types utilized. Suggested protocols for all samplers were submitted to Radian prior to sample collection. A copy of these protocols is appended to this report (Appendix A). The in-house studies related to the optimization of various sampling parameters are discussed below for each sampler. The location of the sampling sites in the Houston area are shown on the map in Figure 1.

FILTER AND ADSORBENT TRAP (IITRI) SAMPLER

The filter and adsorbent trap sampler consisted of a conventional high-volume sampler which had been modified to allow for sampling of vapor-phase material downstream of the aerosol filter. The vapors were collected by passing a portion of the post-filter airstream through cartridges containing a trapping medium consisting of polymeric sorbents. Two sorbent-containing cartridges were connected in series, and 4 such cartridge pairs comprised the vapor sampling unit. This device was designed and constructed by researchers at the Illinois Institute of Technology Research Institute (IITRI), and is referred to in this report as the IITRI sampler.

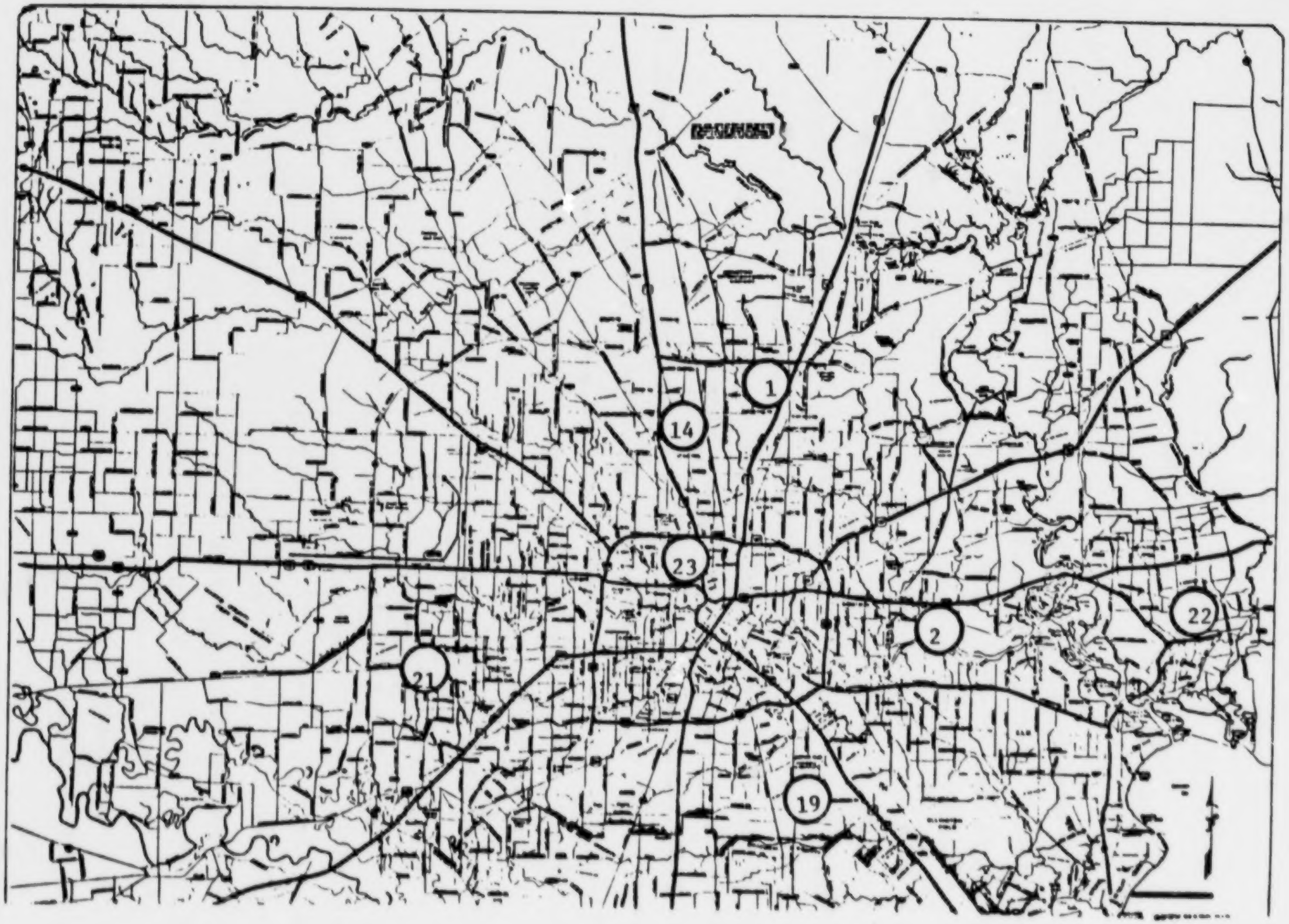
1
14
23
2
22
21
19

Figure 1. Houston area with sampling sites pertinent to this program (sites 1, 2, 14, 17, 19, 21, 22, 23) shown.

A schematic of a single cartridge pair is shown in Figure 2. The cartridge U-tubes and plumbing and fittings were all constructed of stainless steel. The sampler was designed so that any of the four U-tubes could be brought onstream by manipulation of appropriate valves. Air flow through the sampler was controlled at 2.84 L/min by the use of a critical orifice. A total of three IITRI samplers (12 cartridge pairs) were utilized for this program.

Each IITRI sampler loaded with sorbent material was supplied to RTI by the EPA (Aerosol Research Branch, Atmospheric Chemistry and Physics Division). The sorbent selected for use in the samplers was Tenax GC, a phenylene oxide polymer with well tested vapor trapping properties (1-3). This material has been routinely used in our laboratories for vapors analysis for over 4 years; as a consequence sorbent handling and preparation, field sampling and final analysis have been optimized for this medium.

It is essential that all sorbed organic species are removed from Tenax GC before it is released for field use. These materials are normally removed by thermal desorption (4), after which the levels of background materials remaining are assessed by glass capillary gas chromatography/-flame ionization detection (GC/FID) of the desorbed vapors. The procedure and apparatus used for this process have been described (5). This approach was used to determine the levels of background contaminants associated with the Tenax GC contained in the IITRI samplers as received from EPA. This was achieved by placing a Tenax GC filled U-tube (each arm of the U-tube contained ∿ 2.5 g sorbent) in an oven and purging with pre-purified helium (30 mL/min) at 250°C. To insure that the helium was free of trace organics, the gas line was placed in a cold bath (liquid nitrogen) located between the helium cylinder and the oven. After desorption, the background levels of the IITRI cartridge pair were checked by passing the purge gas through a glass cartridge containing cleaned Tenax GC at ambient temperature. This cartridge was then analyzed using established procedures (5). The

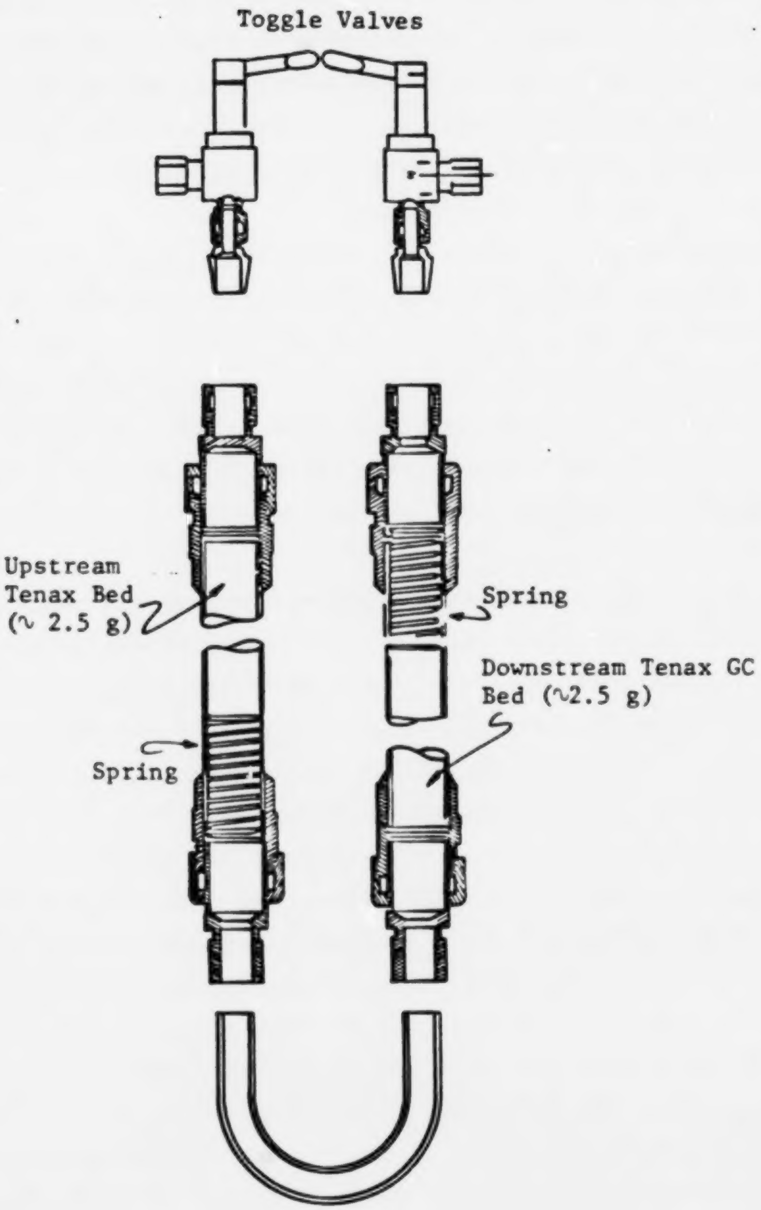
Toggle Valves
Upstream Tenax Bed (~ 2.5 g)
Spring
Downstream Tenax GC Bed (~2.5 g)
Spring

Figure 2. Single cartridge pair - IITRI sampler.

entire process of desorption of the IITRI U-tubes, and use of a downstream Tenax GC cartridge for assessing the degree of background contaminants is shown diagrammatically in Figure 3. In practice it was found necessary to purge the IITRI U-tubes overnite at 250°C before the resin bed was deemed sufficiently clean for release to Radian. All U-tubes were thus cleaned using these same conditions. The results of the background checks for each of the three samplers are shown in Figure 4-6. .Figure 7 shows the results obtained from a background check of an IITRI sampler cartridge pair before clean-up by thermal desorption.

The determination of background levels of Tenax GC contaminants by glass capillary GC/FID has been correlated with total ion current response from the GC/MS using similar GC conditions. The background levels as indicated in Figure 4-6 were within acceptable limits for subsequent GC/MS analysis.

Once the cartridge pairs were cleaned by thermal desorption all U-tubes were reassembled and each sealed sampler was shipped to Houston. The samplers were designated by number (Samplers 1, 2 and 3), and each of the 4 cartridge pairs for each sampler was numbered 1 through 4. In addition, the individual sorbent beds were labeled as either upstream (U) or downstream (D). A single designation, preceded by "IT" for IITRI, thus described each sample. For example the upstream Tenax GC sample from U-tube number 3 from sampler number 1 was referred to as sample number IT1-3U.

All sampling information was recorded on data sheets supplied by RTI to Radian and were returned with each sampler. This information is detailed in Table 1. One cartridge pair for each sampler was utilized as a field blank. The blank was never exposed to the sampling stream, but experienced the same shipment, storage, and handling conditions as the sample cartridges.

DICHOTOMOUS SAMPLES

The dichotomous sampling effort for the Houston study was carried out by the EPA (Inorganic Pollutant Analysis Branch, Atmospheric Chemistry and Physics Division). A portion of the many dichotomous filters used

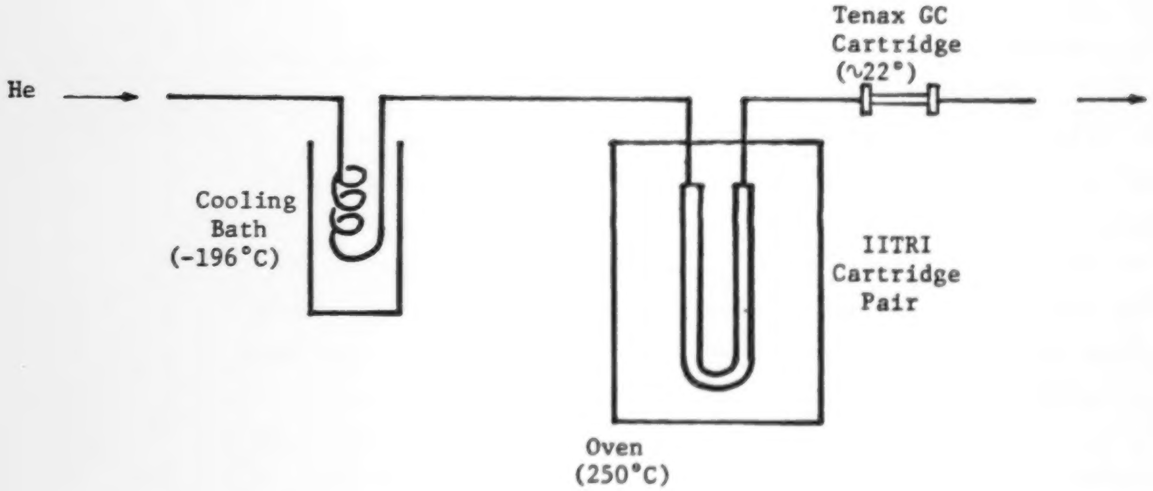
Tenax GC
Cartridge
(∿22°)
He
Cooling
Bath
(-196°C)
IITRI
Cartridge
Pair
Oven
(250°C)

Figure 3. Thermal desorption system for cleaning and background measurement of IITRI cartridges.

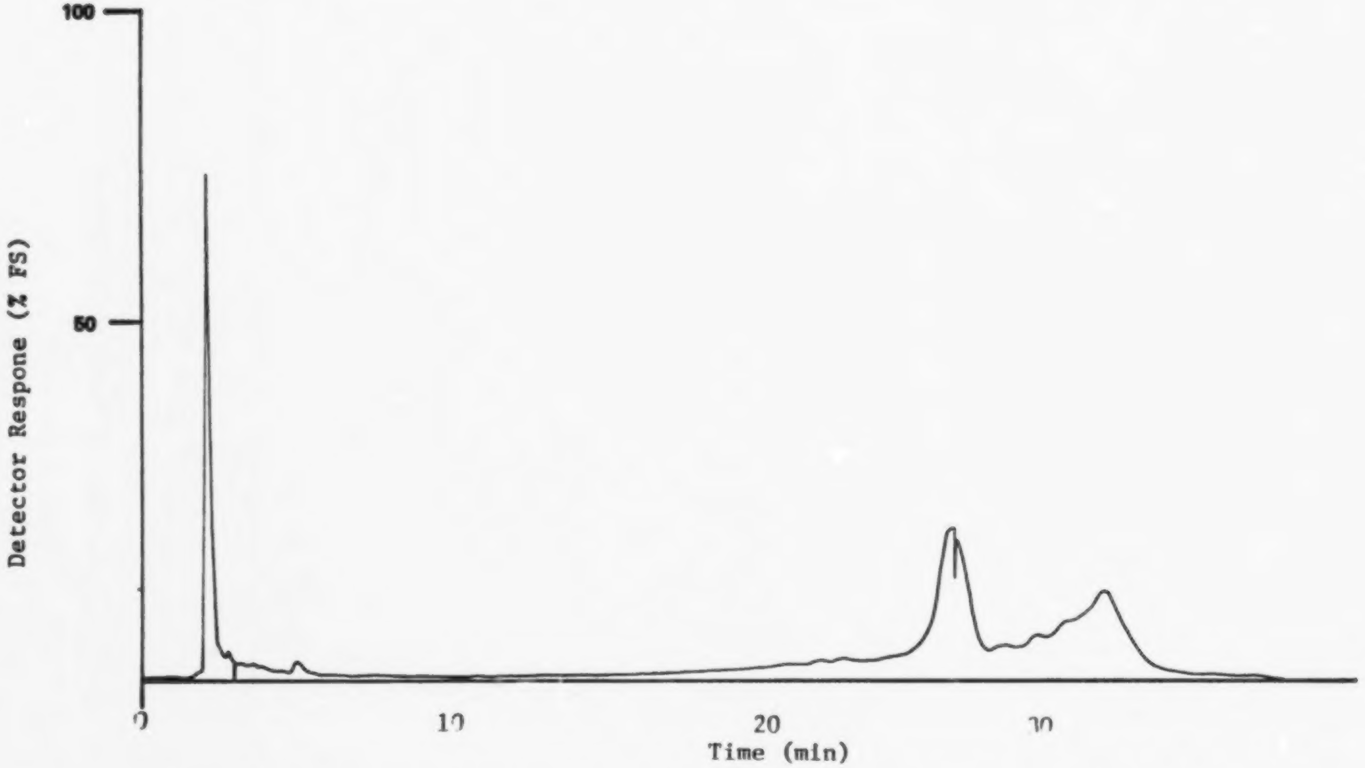

Figure 4. Gas chromatogram (FID) of components desorbed from IITRI cartridge pair - Sampler #1. Glass capillary (WCOT) column, SE-30, programmed from 100° - 240°C at 4^{o}/min. Response: 1.28×10^{-11} Amps FS.

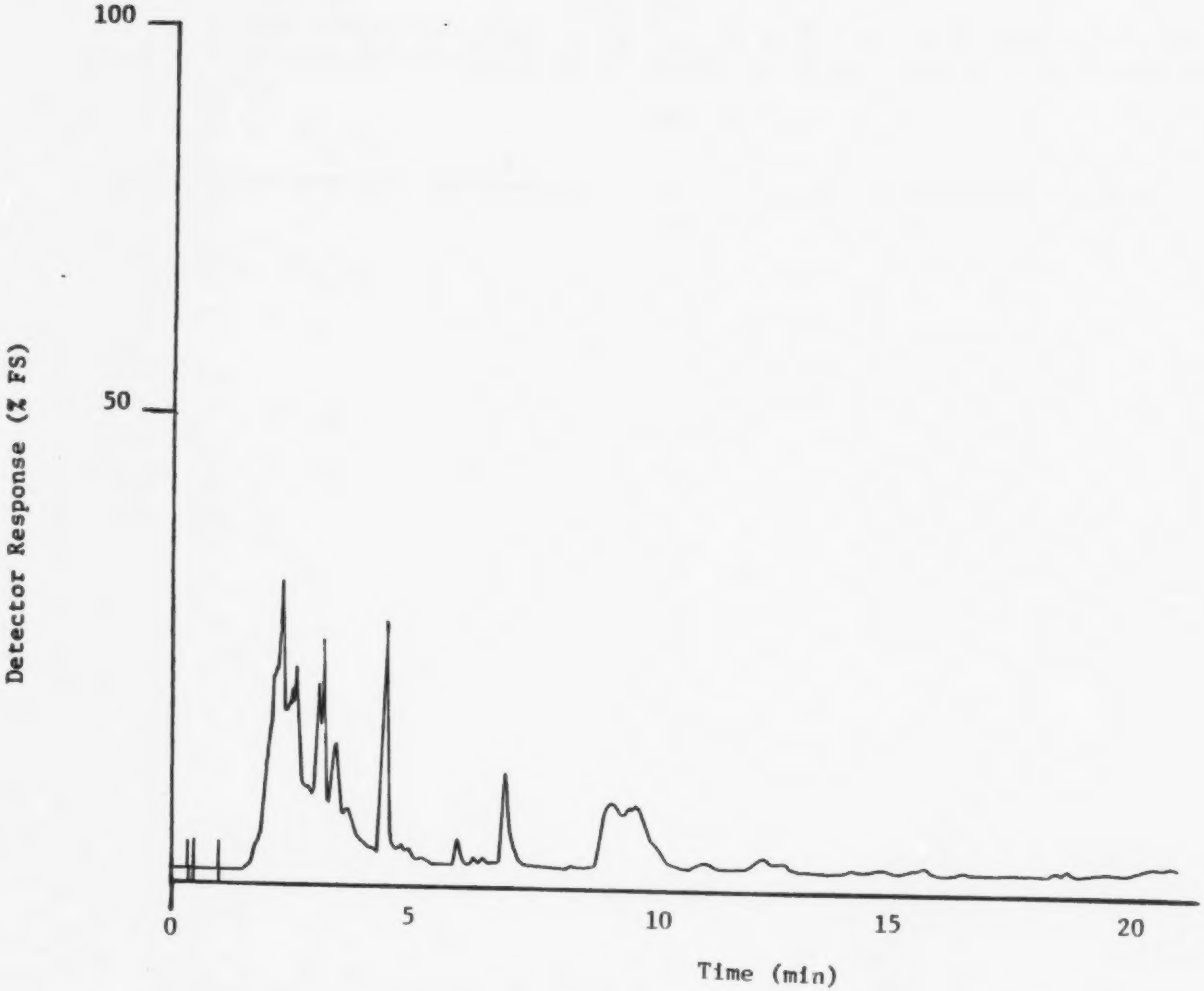

Figure 5. Gas chromatogram (FID) of components desorbed from IITRI cartridge pair - Sampler #2. Conditions as in Figure 4.

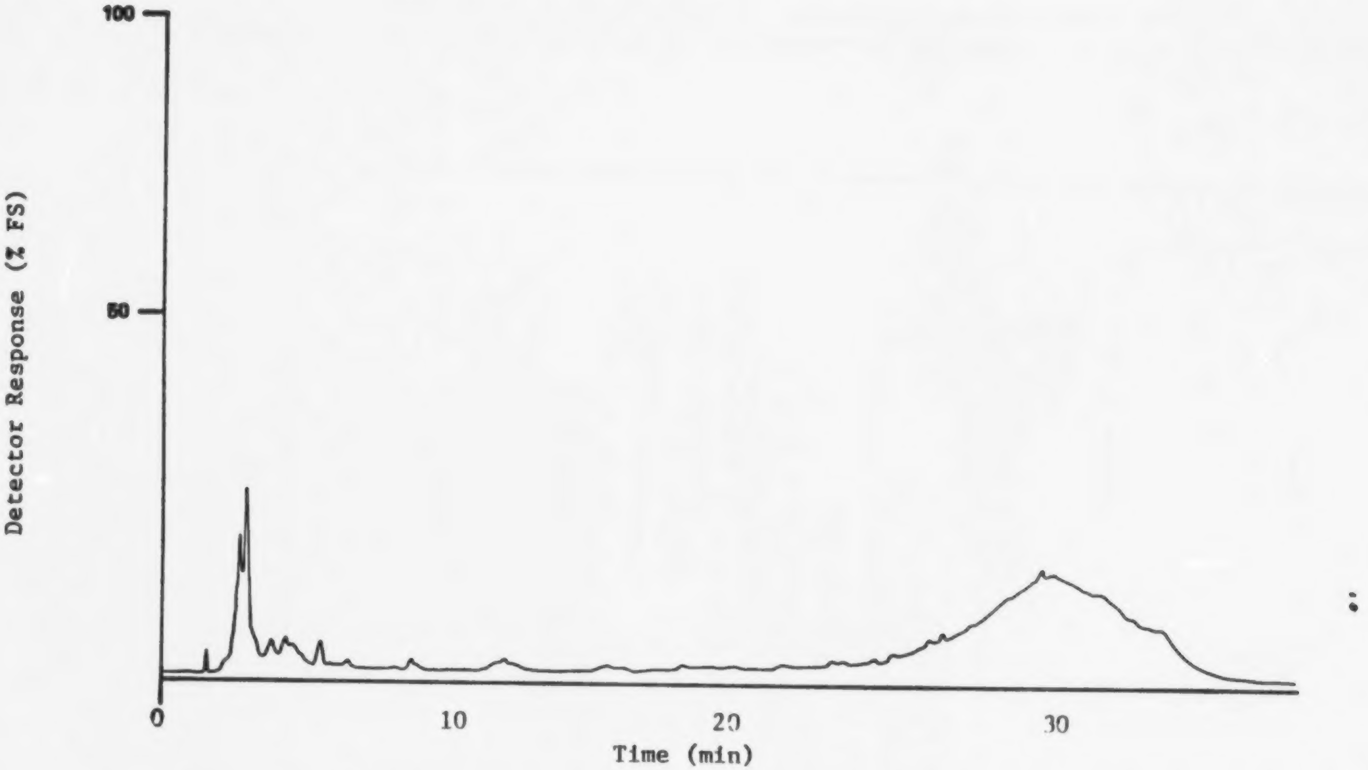

Figure 6. Gas chromatogram (FID) of components desorbed from IITRI cartridge pair - Sampler #3. Conditions as in Figure 4.

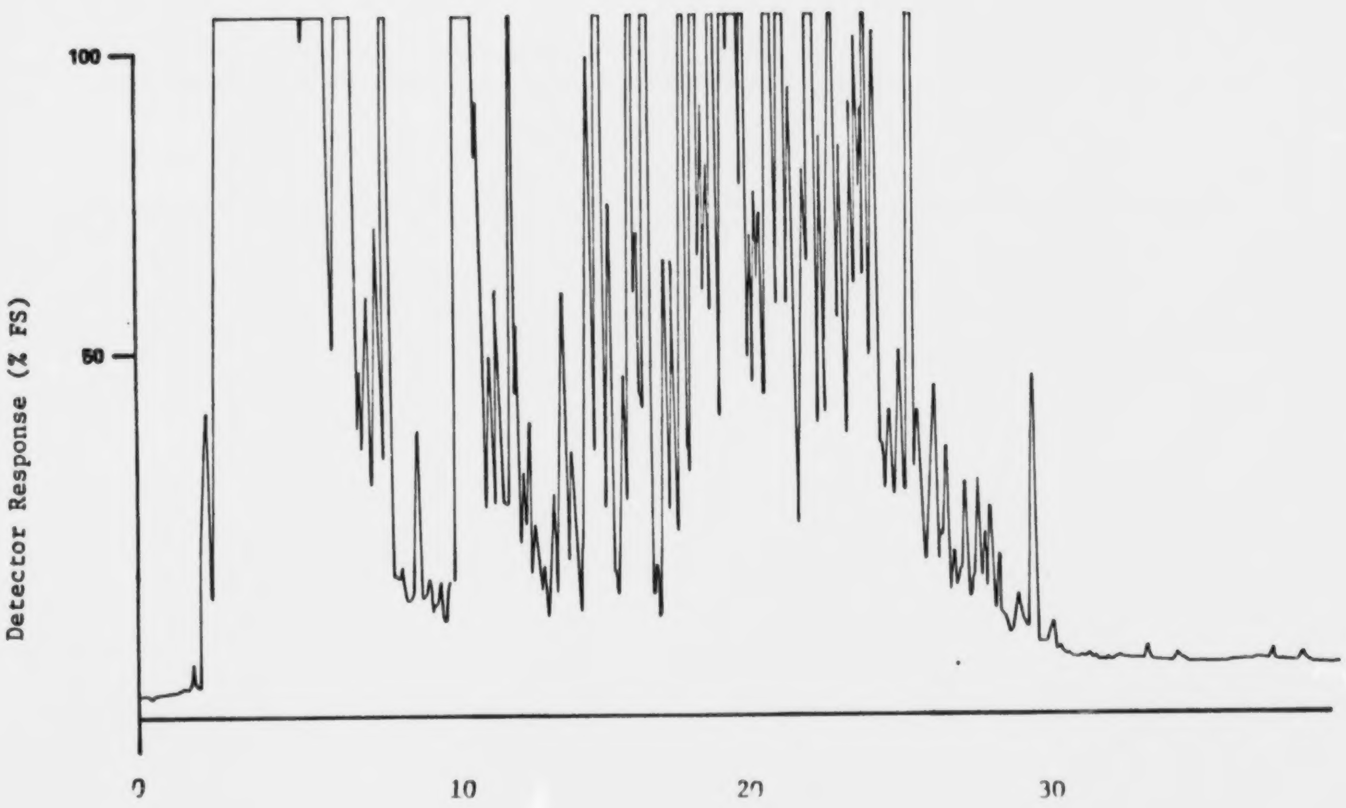

Figure 7. Gas chromatogram (FID) of components desorbed from IITRI cartridge pair-Sampler #1 before clean-up. Conditions as in Figure 4.

TABLE 1. SAMPLING DATA - IITRI SAMPLES

IITRI Sample No.	Site	Sampling Data	Sampling Rate (ℓ/min)	Sampling Time (min)	Sample Volume (L)
IT1-1 (blank)	- - -	- - -	- - -	- - -	- - -
IT1-2	#21-Alief	10-08-78 (day)	2.84	710	2,016
IT1-3	#23-Stude Park	10-06-78 (day)	2.84	720	2,045
IT1-4	#23-Stude Park	10-06-78 (night)	2.84	595	1,690
IT2-1 (blank)	- - -	- - -	- - -	- - -	- - -
IT2-2	#23-Stude Park-Central	10-11-78 (day)	2.84	585	1,661
IT2-3	#23-Stude Park-Central	10-11-78 (night)	2.84	720	2,045
IT2-4	#21-Alief-West	10-10-78 (day)	2.84	720	2,045
IT3-1	#22-Baytown Area-North	10-10-78 (day)	2.84	690	1,960
IT3-2	#22-Baytown Area-North	10-11-78 (night)	2.84	660	1,874
IT3-3	#22-Baytown Area-North	10-11-78 (day)	2.84	720	2,045
IT3-4 (blank)	- - -	- - -	- - -	- - -	- - -

for aerosol collection was shipped to RTI as specified in the sampling protocol (Appendix A). Five "fine" filters were designated for extraction and analysis by RTI. The sampling information for the dichotomous samples is shown in Table 2.

HI-VOL SAMPLES

The high volume samples were collected on quartz fiber filters (Gelman Micro Quartz). Prior to field studies, investigations were conducted in our laboratories to determine the extent of background organics contained in the quartz fiber filters (QFF). Three QFFs were shipped by Radian to RTI for this purpose. These filters were from the same lot, but from three different boxes (personal communication - Mr. R. Mann, Radian Corp.). Each filter was subjected to solvent washing experiments to determine (1) the results of such clean-up procedures and (2) the best wash medium if clean-up was shown to be effective. Analysis of filter extracts and solvent washes was achieved using packed column GC/FID. In order to facilitate comparisons all sample and injection volumes were identical.

The effect of washing on an unused QFF was first examined by dividing filter #1 into halves. One half was cut into small squares and Soxhlet extracted with methanol for 2.5 hrs. The remaining half was washed by immersion in 80 mL of methanol/chloroform (1:1). This washing was repeated twice. The filter half was then cut into small squares and extracted in the same fashion as the unwashed filter half. The Soxhlet extracts from each filter half were reduced to dryness, brought to known volume and analyzed. The results are shown in Figure 8. The extracts from the washed filter half clearly contain less material than the extracts from the unwashed half. Based on injections of known concentrations of standard materials (naphthalene and dodecane) under identical GC conditions, the levels of compounds indicated in Figure 8 represent µg quantities of filter contaminants.

A similar experiment was conducted on a second QFF using diethyl ether as the wash solvent instead of methanol/chloroform. Chromatograms representative of the washed and unwashed portions of a blank filter are shown in Figure 9. As with the previous experiment, significant levels

TABLE 2. SAMPLING DATA - DICHOTOMOUS SAMPLES

Dichotomous Filter No.	Houston Site	Sampling Date	Sampling Rate (ℓ/min)	Sampling Time (hr)	Sampling Volume (m^3)
4F-011	#19	9-27-78 (night)	16.7	12.0	12.0
4F-012	#19	9-28-78 (day)	16.7	12.0	12.0
4F-018	#17	10-6-78 (day)	16.7	11.8	11.8
4F-021	#21	10-9-78 (day)	16.7	12.0	12.0
4F-022	#21	10-10-78 (day)	16.7	12.0	12.0

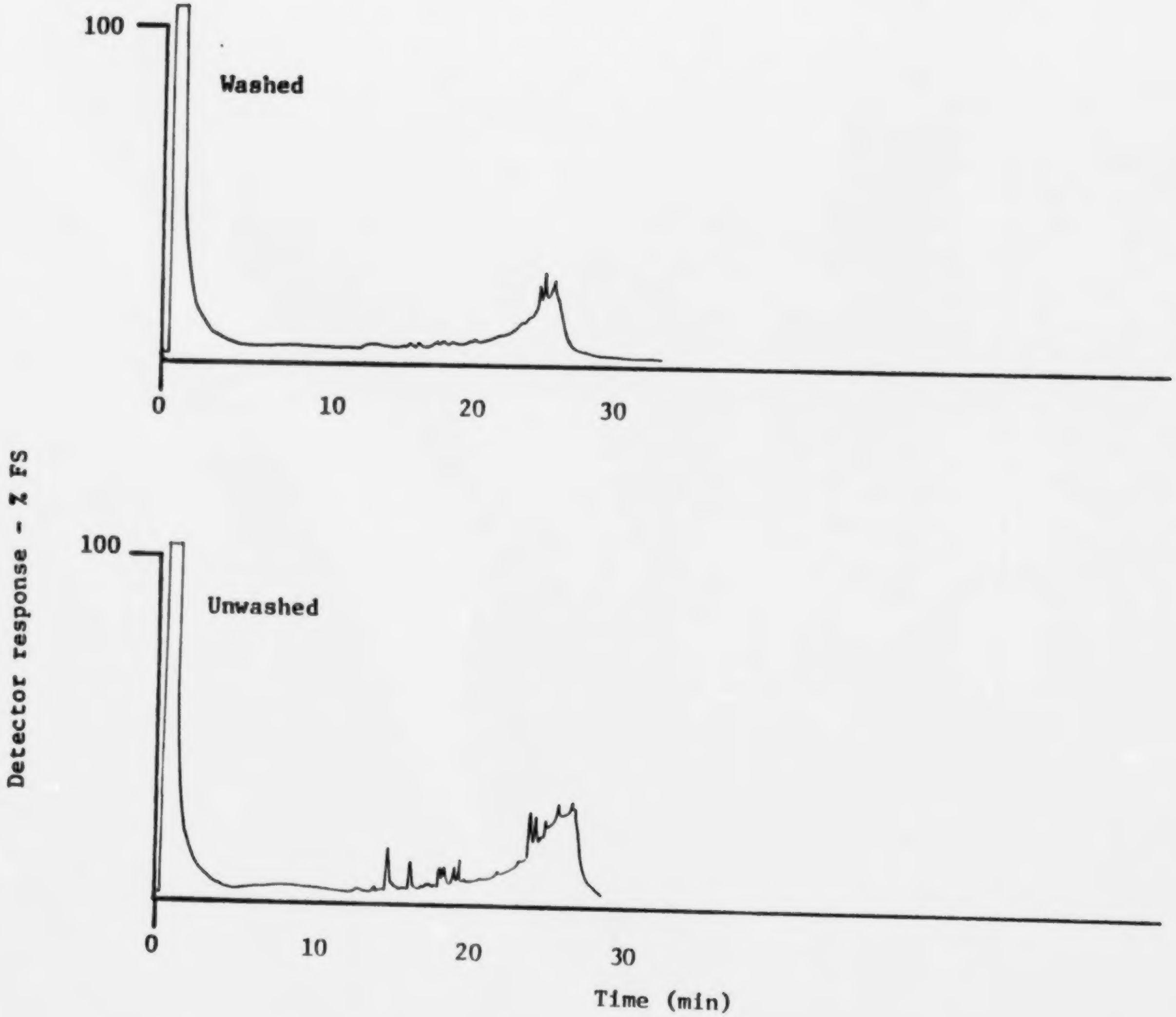

Figure 8. Gas chromatograms (FID) of washed (methanol/chloroform) and unwashed Hi-Vol filter blank #1. Column: 0.2% Carbowax 20M. Temperature: 70°C for 5 mins, programmed at 8°/min to 240°C. Response: 1.6×10^{-10} Amps FS.

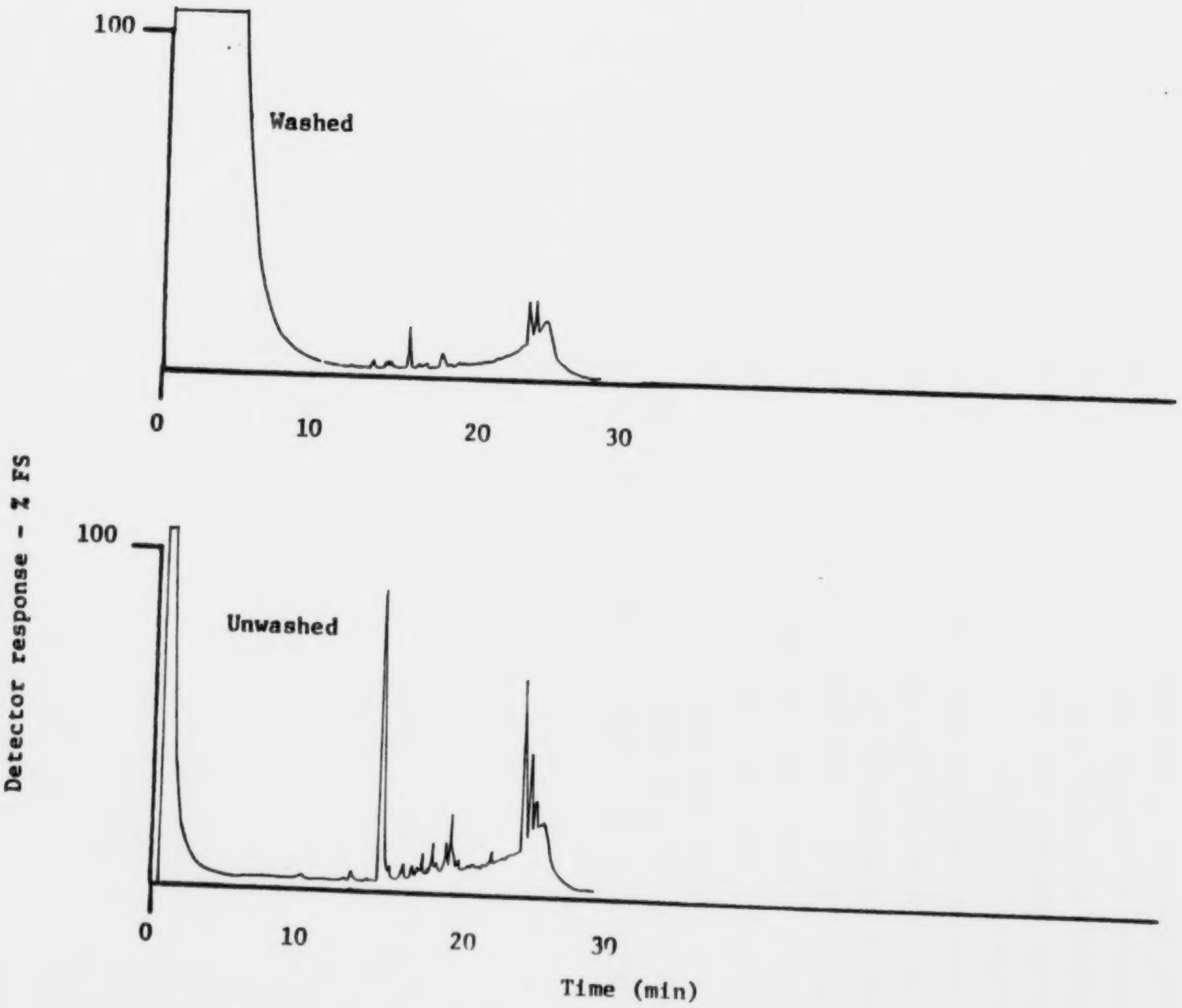

Figure 9. Gas chromatograms (FID) of washed (ether) and unwashed Hi-Vol filter blank #2. Conditions as in Figure 9.

of background contaminants were removed by solvent washing. Greater response is evident for the unwashed portion of this filter than was observed for the unwashed portion of the first filter examined. This indicates some variation in background for filters from the same manufactured lot. This result was also obtained independently by similar experiments conducted at Radian Corporation (personal communication - Mr. R. Mann).

A comparison was then made of the efficacy of the two previously tested solvent systems, i.e., methanol/chloroform and diethyl ether, in cleaning portions of the same filter. A QFF was divided into quarters and treated as follows: one quarter was washed with methanol/chloroform and Soxhlet extracted with methanol; one quarter was unwashed and Soxhlet extracted with methanol; the remaining quarter was unwashed and Soxhlet extracted with ether.

Results from these procedures are shown in Figures 10 and 11. While both solvents remove significant amounts of contaminants; methanol/-chloroform is more efficacious than ether for this purpose using the wash procedure described above. In addition, a variation in contaminant levels for filters from the same lot, as observed by Radian was noted. These results were conveyed to Radian prior to field sampling.

Data sheets were supplied to Radian for recording pertinent sampling information, and were returned to RTI. The sampling data for the Hi-Vol filters used in this study are shown in Table 3.

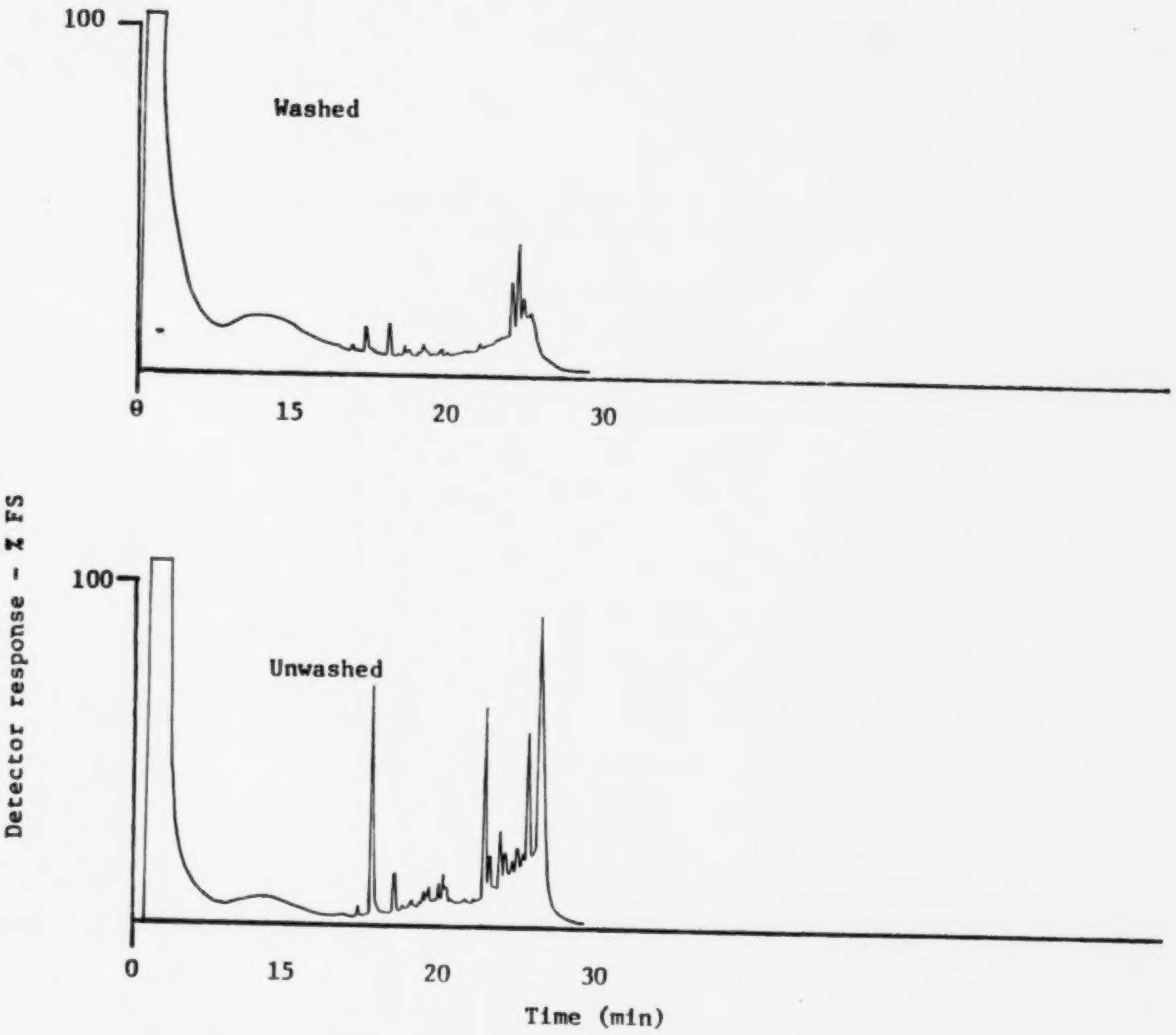

Figure 10. Gas chromatograms (FID) of washed (methanol/chloroform) and unwashed. Hi-Vol filter blank #3. Conditions as in Figure 8.

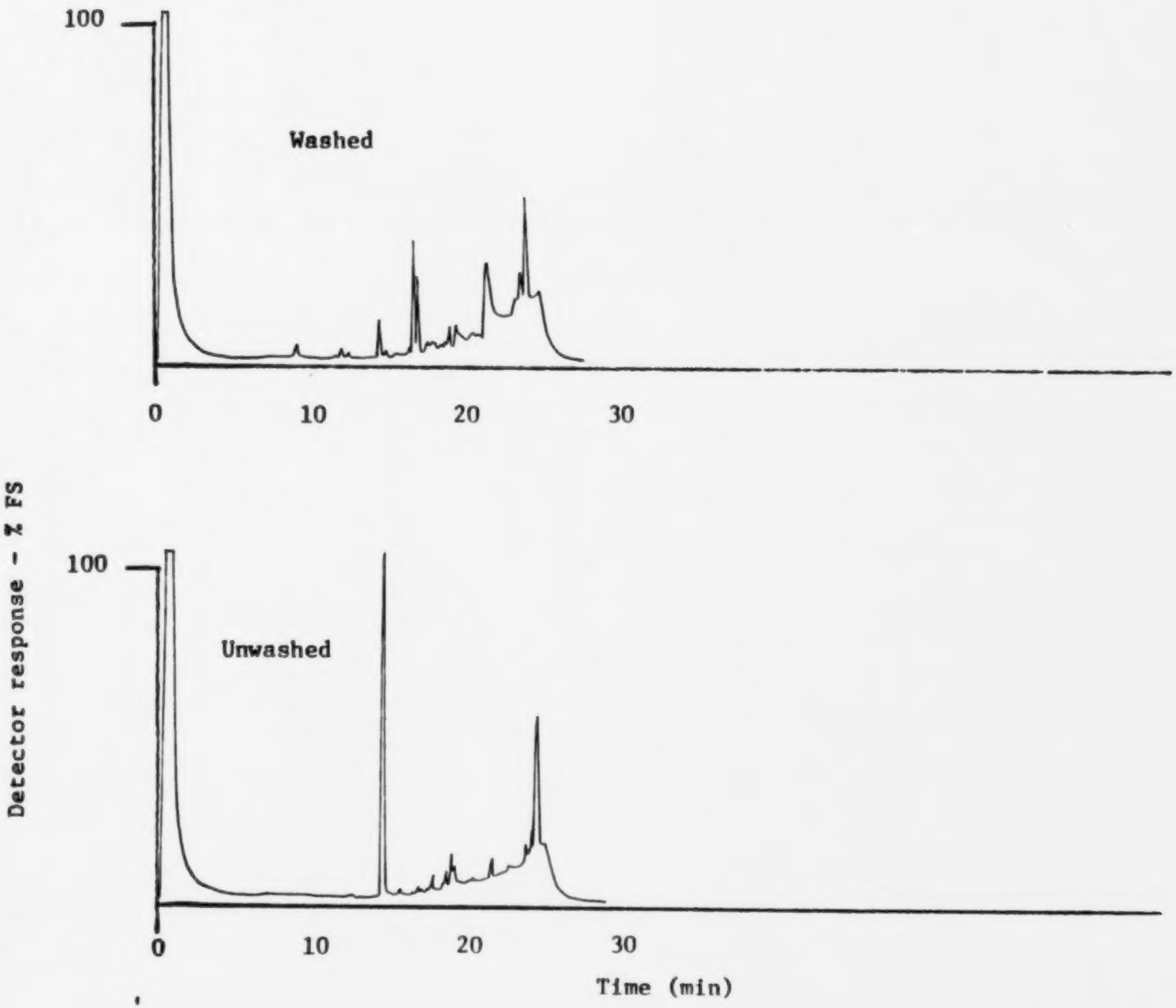

Figure 11. Gas chromatograms (FID) of washed (ether) and unwashed Hi-Vol filter blank #3. Conditions as in Figure 8.

TABLE 3. RECOVERY OF ^{14}C-DIMETHYLBENZ(a)ANTHRACENE (74,627 dpm) AFTER CONCENTRATION IN SCHENCK-BAUER SEDIMENTATION TUBES

Tube	Total dpm in 10 µℓ	%	Total dpm in 500 µℓ	%	Total dpm in 3.0 ml	%	Total Recovery %
1	58843	78.8	4686	6.3	0	0	85.1
2	51286	68.7	11214	15.0	0	0	83.7
3	44865	60.1	13999	18.8	831	1.1	80.0

SECTION 6

SAMPLE ANALYSIS

To minimize problems associated with sample decomposition, all analytical work was carried out in a laboratory which was fitted with yellow lights (transmission ≥ 500 nm); samples and sample extracts were never allowed to exceed 50°C, and were stored under conditions of refrigeration and darkness.

IITRI SAMPLES

The analysis of the collected vapors adsorbed to the Tenax GC beds in the IITRI samplers commenced by removal of the Tenax GC and transfer of a measured portion of the resin to clean glass cartridges. The cartridge contents were then analyzed by capillary GC/MS. The whole sample was introduced to the analytical system by thermal desorption into a cryogenic capillary trap and thence rapidly swept onto the chromatographic column. Each cartridge was loaded with a known amount of perfluorobenzene and perfluorotoluene for use in quantitation. Qualitative data interpretation was done by visual interpretation of the spectra and comparison with standard reference spectra. Quantitation was achieved by peak intensity determination of a characteristic mass for a compound from the chromatographic peak. The amount of compound in the sample was then calculated using the relative molar response factor and the integrated area for a standard. The concentration in ambient air was then calculated using the volume sampled. Complete details of the sample analysis are given in Appendix B.

DICHOTOMOUS SAMPLES

Preliminary Experiments

The dichotomous sampler was designed to collect aerosol for size fractionation, mass determination, and compositional characterization (6). The sample rate (16.7 L/min) is low compared to the commonly used

Hi-Vol sampler (> 600 L/min), and thus the amount of aerosol collected is smaller. Since organics typically comprise 5-15% of the total mass of air aerosol (7), and since only a limited fraction of a sample extract can be introduced into the GC/MS system, experiments were undertaken prior to field sample analysis, to optimize the organics recovery procedure. Efforts were directed toward reducing the extracts to the smallest practical volume since the maximum aliquot that could be removed for GC/MS injection was fixed at ~ 1 μL. To introduce even 10% of the sample would therefore require the reduction of the dichotomous filter extract to a volume of ~ 10 μL. Given the small amounts of organics likely to be present, and the size of the containers available for use, concentrations of an extract to low μL volumes without concomitant, significant losses of sample components, presented some difficulty.

Information obtained from the EPA (Ms. C. Sawicki, Inorganic Pollutant Analysis Branch, ESRL, RTP) led us to examine Schenk-Bauer sedimentation tubes as appropriate containers for sample concentration. These vials are calibrated for 3.0 mL liquid volume, and consist of an upper, wide-body portion (~ 2.5 mL) and a lower, narrow-body, tapered tube. The lower portion is of sufficiently narrow dimensions that 10 μL liquid volume can be aliquotted accurately and reproducibly. Our tests were aimed at assessing the extent of compound losses realized during concentration of non-volatile components from a large volume to dryness, and reconstitution and dissolution of sample in 10.0 μL solvent.

Recoveries were determined using radiolabeled material, with each experiment designed to reflect sample losses due to processes such as irreversible glass surface adsorption or vaporization. The recovery standard chosen was ^{14}C-7,12-dimethylbenz(a)anthracene, a compound presumably representative of an important class of aerosol organics. The compound (~ 70,000 dpm, ~ 70 ng) was added, in a 2 mL chloroform, to each of 3, surface protected (silanized), sedimentation tubes. The solvent was removed by gentle nitrogen blowdown. Three 2.0 mL portions of chloroform were added and the drying process repeated for each portion. The walls of the tubes were then washed 3 times with 100 μL portions of chloroform, blowing to dryness after each washing. This washing process was repeated (3 times each) with 50 μL and 20 μL solvent additives. To the dried sample after the final wash was added 10.0 μL chloroform. An aliquot of 5.0 μL were removed for counting, and the remaining 5 μL were discarded. Then, to assess the amount of sample left on the walls of the tube during blowdown, 500 μL of solvent were added and 100 μL were removed for counting. The remainder was discarded and 3.0 mL of solvent were added and 1.0 mL aliquots removed for counting. The recovery results are shown in Table 3. The data indicate small but significant overall losses (∼ 15%). Of more significance is the fact that ∼ 70% of the labeled material was concentrated in 10 μL of solvent. The larger solvent additions of 50 μL and 3 mL show evidence of some material (∼ 6-20%) left on the walls of the container. These results indicate that a significant amount of material can be recovered in a small volume of solvent, from which aliquots can be removed for GC/MS analysis. Variations in the precise extent of recovery can be compensated through the use of internally added standards.

Based on the above study, final concentration of dichotomous filter extracts was achieved using Schenck-Bauer sedimentation tubes. Each dichotomous filter was extracted using a custom made Teflon® extraction block provided by the EPA (Inorganic Pollutant Analysis Branch). Two extractions were carried out with ∼ 4 mL of chloroform (Burdick-Jackson) and a sonication in water bath. The extracts were combined and internal standard (anthracene-d_{10}) added. The extract was then transferred in portions to the sedimentation tubes for solvent removal. Just prior to GC/MS analysis, the dried extracts were reconstituted in 10.0 μL of chloroform. Approximately 1 μL was removed for injection onto the GC column. Details of the entire procedure are given in Appendix C.

HI-VOL SAMPLES

Extraction/Partition

Hi-Vol filters (QFF) were extracted overnight with methanol (Burdick-Jackson) using a Soxhlet apparatus following the procedure of Hill et al (8). Following solvent removal the residue was fractionated according to the scheme presented in Figure 12. The individual fractions were then concentrated for GC/MS/COMP analysis. This extraction scheme was developed under another contract (9).

The efficacy of the scheme was assessed by subjecting a mixture containing known amounts of compounds to the partition procedure. The mixture consisted of benzoic acid, phenol, quinoline, hexadecane, phenanthrene and ethylene glycol. The compounds were chosen to represent the five classes of materials produced by the partition scheme (all these materials have been found in air particulate samples, except ethylene glycol). No information on the composition of the polar neutral fraction was available, therefore ethylene glycol was included as a likely component of this fraction based on its known chemical properties. The experiment was conducted using both large and small mass samples. Recoveries were determined gravimetrically.

As a further check on the procedure, thin layer chromatography (TLC) scans were conducted on each fraction to ascertain the extent, if any, of compound spillover into other fraction(s). No such spillover was detected.

GC/MS/COMP Analysis

Samples were analyzed using a LKB 2091 gas chromatography/mass spectrometer with a dedicated PDP-11/34 data system. The samples were chromatographed on an OV-101 capillary column (25 m, WCOT, obtained from LKB). The column was held at 100°C for 2 minutes after injection, and then heated to 265°C at a rate of 8°/min. Carrier gas flow rate was 1.8 mL/min. Injector temperature was 245°C. Mass spectral scans were taken every 3 sec scanning from 5-492 amu. The ion source temperature was 210°; electron energy, 70 eV; trap current, 50 μA; accelerating voltage, 3500 V; and multiplier setting 400-450. Total ion current and mass spectra plots were generated for interpretation.

Data were interpreted by comparison of the unknown spectra with standard reference collections. Where no reference spectrum was available, or where spectral quality was not sufficient for positive identification,

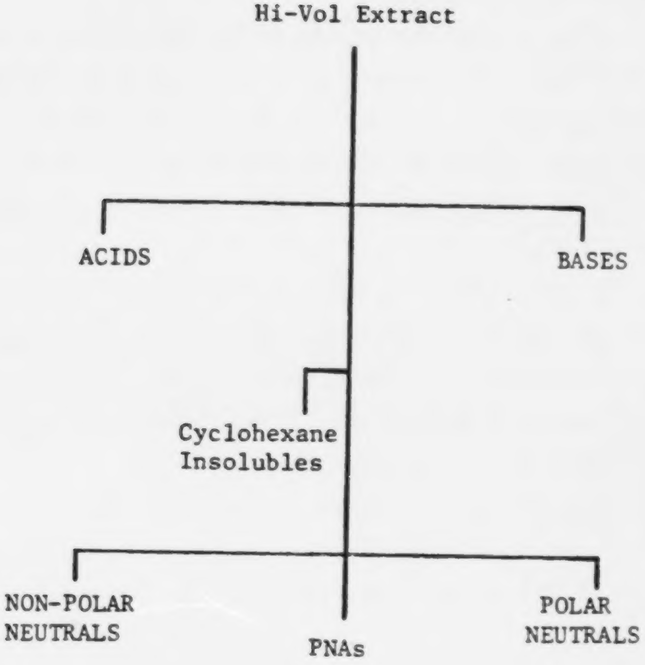
Hi-Vol Extract
ACIDS
BASES
Cyclohexane Insolubles
NON-POLAR NEUTRALS
PNAs
POLAR NEUTRALS

Figure 12. Fractionation scheme used for fractionating Hi-Vol filter extracts.

the compounds were labeled "tentative". Further validation of equivocal identifications was made by consultation with other chemists and spectroscopists experienced in similar research. This mass spectral interpretation protocol was established to extract the maximum information from the data and to guard against misidentification. The specific compound identification criteria are listed below:

Level I Computer Interpretation. The raw data generated from the analysis of samples are subjected to computerized deconvolution/library search and compound identification made using this approach has the lowest level of confidence. In general, Level I is reserved for only those cases where compound verification is the primary intent of the qualitative analysis.

Level II Manual Interpretation. The plotted mass spectra are manually interpreted and compared to those spectra compiled in a data compendium by a skilled interpretor. In general a minimum of five masses and intensities (± 15% deviation) should match between the unknown and library spectrum. This level does not utilize any further information such as retention time since the authentic compound may not be available for establishing retention times.

Level III Manual Interpretation Plus Retention Time/Boiling Point of Compound. In addition to the effort as described under Level II, the retention time of the compound is compared to the retention time which has been derived from previous chromtographic analysis. Also the boiling point of the identified component is compared to the boiling points of other compounds in the near vicinity of the one in question when a capillary coated with a nonpolar phase has been used.

Level IV	Manual Interpretation Plus Retention Time of Authentic Compounds. Under this Level, the authentic compound has been chromatographed on the same capillary column using identical operating conditions and the mass spectrum of the authentic compound is compared to that of the unknown.
Level V	Level IV Plus Independent Confirmation Techniques. This Level utilizes other physical methods of analysis such as gc/Fourier transform/ir, gc/high resolution mass spectrometry, or nmr analysis. This Level constitutes the highest degree of confidence in the identification of organic compounds.

SECTION 7

RESULTS AND DISCUSSION

All samples were analyzed by glass capillary GC/MS. Within the limits of this technique, complete identification of the organics isolated from each sampler medium was made. Of the compounds identified, certain components were selected for quantitation. The selection was based on relative abundance and known hazard potential of each compound, and was made after consultation with the project officer. The results for each of the three sample types are discussed individually below.

IITRI SAMPLES

The IITRI sampler constituted the "filter and adsorbing trap" sampler used for the Houston study. Three IITRI samplers were utilized for field studies. Five quartz fiber filters were returned for analysis of aerosol organics (a blank filter was subsequently made available for analysis), and 12 sorbent containing cartridge pairs (9 samples, 3 blanks) were returned for analysis of volatiles.

Volatiles - Qualitative Analysis

The twelve IITRI cartridge tubes contained an upstream and a downstream Tenax GC bed (~ 2.5 g Tenax GC/cartridge) thus providing 24 samples for analysis. Analysis of both the upstream and downstream cartridges for all blanks and for 2 sample cartridges was carried out. For all of these samples it was evident that the analysis of the downstream cartridge represented a duplication of effort since (a) a large number of compounds (> 50) were found on both the upstream and downstream cartridge, (b) the same compounds were found on the downstream as the upstream cartridge, and (c) no useful information was obtained by virtue of analysis of the downstream cartridge. Only the upstream cartridge was therefore analyzed for the bulk of the volatiles samples. A summary of those samples analyzed is provided in Table 4. For each sample a gas chromatogram, in the form of a total ion current (TIC) plot (TIC vs mass

TABLE 4. SAMPLING DATA - HI-VOL SAMPLES

Hi-Vol Filter No.	Houston Site	Sampling Date	Sampling Volume (m^3)	Sampling Period
12	1	9-18-78	1047	0600-1800
13	2	9-18-78	1002	0615-1755
14	19	9-18-78	863	0610-1805
15	14	9-18-78	1176	0615-1800
65	1	10-2-78	843	0600-1730
66	2	10-2-78	1073	0550-1735
89*	23	10-5-78	766	1945-0540
90*	21	10-8-78	911	0600-1750
104*	21	10-10-78	949	0600-1810
109*	22	10-10-78	862	0600-1730
113*	22	10-10-78	774	1855-0550

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*Run with IITRI samplers.

TABLE 5. SUMMARY OF ANALYSIS OF IITRI VOLATILES

IITRI Sample No.*	Qualitative Analysis by GC/MS**	Number of Components Identified
IT1-1U (Blank)	+	82
IT1-1D (Blank)	+	46
IT1-2U	+	174
IT1-2D	+	112
IT1-3U	+	147
IT1-3D	+	104
IT1-4U	+	167
IT1-4D	-	-
IT2-1U (Blank)	+	89
IT2-2D (Blank)	+	69
IT2-2U	+	165
IT2-2D	-	-
IT2-3U	+	153
IT2-3D	-	-
IT2-4U	+	149
IT2-4D	-	-
IT3-1U	+	68
IT3-1D	-	-
IT3-2U	+	104
IT3-2D	-	-
IT3-3U	+	107
IT3-3D	-	-
IT3-4U (Blank)	+	81
IT3-4D (Blank)	+	70

*Sample Code: IT3-4U refers to IITRI Sampler #3, cartridge pair #4, upstream cartridge.

**+ indicates analysis performed.
- indicates analysis not performed.

spectral scan number), was obtained. Each peak of the TIC plot was numbered and the identification of all compounds corresponding to each peak was tabulated. The results for all IITRI samples analyzed are depicted in Appendix E.

As is evident from the tables, a large number of compounds was identified for each cartridge. With one exception from 104-174 compounds were characterized for each upstream cartridge, with approximately 2/3 of these components detected on the corresponding downstream cartridge. The appearance of relatively large numbers of components on the downstream cartridge indicates significant breakthrough from the upstream cartridge. In view of the volume of air sampled (Table 1), and the known breakthrough volumes for similar components using Tenax GC under similar conditions (Table B-2), these findings are not surprising. The vast bulk of volatile species (~ 80-85%) was identified as saturated/-monounsaturated hydrocarbons and alkylated aromatic hydrocarbons. For the amount of Tenax GC used and the temperatures at which sampling was carried out, the breakthrough volumes for these compound types are on the order of 0-100 L and 100-1000 L respectively. The amount of air sampled for the IITRI cartridges averaged ~ 2000 L.

The qualitative data from the IITRI cartridge analysis shows a considerable number and amount (from TIC) of compounds associated with the blank cartridges. These cartridges were never intentionally exposed to ambient air, and thus should have produced gas chromatographic patterns similar to those shown in Figures 4-6. The intensity of the chromatographic pattern obtained for the blanks (Figure E-1, E-2, E-8, E-9, E-16, E-17) indicates exposure of these cartridges to ambient air. This was presumably due to leakage through either the toggle valves controlling air flow to the IITRI U-tubes or the Swagelok fittings.

The qualitative profile of the volatile components collected by the IITRI samplers is very similar to results obtained by other workers at various urban sites. Approximately 150 compounds were identified from each cartridge. Of these ~ 60% were saturated/monounsaturated hydrocarbons, ~ 20-25% were aromatics, ~ 5% were halogenated hydrocarbons, and the remaining components (~ 10-15%) consisted of oxygenated compounds (aldehydes, ketones, ethers). This composition is similar with regard to compound type and molecular weight range to results of Houston air volatiles analysis as reported by Bertsch et al (10). The vapor phase organics, as determined by Louw et al (11) for two South African cities, also exhibit a similar compositional pattern as do a number of European and Canadian sites (12-14).

Sampling for vapor phase material was carried out at three sites (Figure 1), Alief, Stude Park and Baytown. These sites represent, respectively, a suburban community, the downtown area and a heavily industrialized site. Based solely on the qualitative results, no major trends or characteristics regarding site specificity were noted. Although similar volumes of air were sampled at each site, the average number of compounds identified from the Baytown samples was less (93) than the average number identified from Alief (162) or Stude Park (158). While this observation may be noteworthy, the limited number of samples analyzed from each site and the excessive volume of air sampled for the amount of Tenax GC used, detract from its significance.

No significant differences were noted between results obtained for samples collected during the day and those collected at night (Tables 1, E-7 and E-11).

Volatiles - Quantitative Analysis

Using the method of quantitation for vapors as described in Appendix B, 12 components from each IITRI cartridge were analyzed. The selection of compounds for quantitative determination was based on considerations of relative abundance and toxicity. These criteria were adopted following consultation with the project officer. Toxicity information was obtained from the "Handbook of Environmental Data on Organic Chemicals" (15).

Using the method of relative molar response (RMR) factors, reference quantitation standards were obtained and their GC/MS response relative to an internal standard was determined under the same conditions as were used for the analysis of field samples. In some cases duplication of effort was avoided by the determination of RMRs for several similar species using a single, representative standard.

Thus, the RMR for the C_3-benzene isomers (trimethylbenzenes. methylethylbenzene was determined using 1,3,5-trimethylbenzene. It is known from past experience that structurally similar compounds generally produce similar response factors.

The total mass of each species was divided by the volume of air sampled to provide ambient air concentrations. These quantitation results are shown in Table 6. In one case, i.e., methylene chloride, the large amount of material introduced to the GC/MS produced analyzer saturation. For this compound a minimum concentration is therefore reported. However, as noted previously, the relatively large volume of air sampled exceeded the known breakthrough volumes (BTVs) for most components. Thus all quantitative results must be interpreted as minimum concentrations. For example, from Table B-2, the BTV, at 70°F (the average ambient temperature during field sampling) for saturated hydrocarbons after correction for the amount of Tenax GC used, is < 100 L. For the halogenated alkyl compounds selected for quantitation, the BTV is < 200 L. Aromatic compounds have much larger BTVs than alkyl compounds; lower alkylated species (benzene, toluene, ethyl benzene, xylenes) have BTVs < 1000. Other aromatics possess higher BTVs. All IITRI samplers were operated at identical flows for approximately the same length of time. The average volume of air sampled was 1930 L. It is thus clear that for most if not all of the compounds listed in Table 6, BTVs were exceeded, and consequently the accuracy of the results is suspect. For most purposes the concentration values listed for each component are best considered as minimum values.

Levels of the same compounds that were quantitated in this study have been reported by others, both for the city of Houston (10,16) and other urban areas (11-14). Louw (11) has summarized these findings for 13 non-halogenated compounds as determined in 8 cities. A comparison of the range of concentrations for seven representative components as determined by this study and as reported by Louw is shown in Table 7. Levels for all compounds are roughly comparable.

Data are available from a previous study in the Houston area regarding halogenated hydrocarbons (16). A comparison of these values

TABLE 6. QUANTITATION RESULTS FROM IITRI VOLATILES ANALYSIS

Compound	Concentration (ng/m^3)								
	IT1-2U	IT1-3U	IT1-4U	IT2-2U	IT2-3U	IT2-4U	IT3-1U	IT3-2U	IT3-3U
n-Hexane					5920		998	4115	788
methylcyclohexane							126		
n-heptane					1582				
n-octane	1059								
n-nonane	1086		4211	4561	1052				
n-decane	1418	1796	6049	9631	1209			203	
n-undecane	2495	2478	4285	9201	1963	2476			
n-dodecane	880	811		33454					
n-tridecane				3112					
benzene	6636						158	3393	1169
toluene	2860	10443	11214	23698	14197		1319	6242	
ethylbenzene			8126			5336		1458	99
xylene isomer	3835		8064	21841	8239	20124		2475	47
xylene isomer	1659	1362		7763	1725	4781		643	5
1,2,3-trimethylbenzene		333	1151			337			22
1,2,4-trimethylbenzene	234	233	1383	2240	371	4107			
1,3,5-trimethylbenzene		473	1253			766			
ethyltoluene isomer		181	1650	756		208	429		
styrene		165	8971	4078	1480	677	104	721	64
naphthalene		7169							22
chloroform							685		236

(continued)

TABLE 6. (CONT'D)

	Concentration (ng/m^3)								
Compound	IT1-2U	IT1-3U	IT1-4U	IT2-2U	IT2-3U	IT2-4U	IT3-1U	IT3-2U	IT3-3U
carbon tetrachloride							388	1922	
methylene chloride	4142	3624	27817	79281	13451	169982	149526	284218	15200
1,2-dichloroethane							219		
trichloroethylene					3172	6786	2543	1967	1414
1,1,1-trichloroethane						179	79	216	
dichlorobenzene									15

TABLE 7. CONCENTRATION RANGES (PPB) OF SELECTED AIR VOLATILES AS DETERMINED FROM THE HOUSTON STUDY AND AS REPORTED FOR OTHER CITIE (Ref. 11)

Compounds	Concentration range (ppb) Houston	Other urban areas**
n-octane	0.1	0.7 - 1.4
n-nonane	0.1 - .5	0.1 - 4.4
n-decane	0.1 -1.0	0.5 - 2.7
benzene	0.0 -1.0	3.4 - 54
toluene	0.2 -3.7	0.3 - 39
ethylbenzene	0.2 - .6	1.5 - 8.7
xylene	0 -3.0	0.2 - 30
trimethylbenzenes	0- .2	0.3 - 9
ethyl toluene	0- 0.1	0.2 - 9

* As determined in this study.

** As determined by other investigators for the cities of Pretoria, Johannesburg, Durban, Paris, Houston, Zurich, Los Angeles and The Hague (ref 11).

with those obtained from the present study is shown in Table 8. Five compounds were common to both studies. It should be noted that the previously reported data reflects ambient air concentrations in industrialized areas. Overall, the levels are within the same range of values.

Non-Volatiles

Since each IITRI sampler was used in conjunction with a Hi-Vol sampler, a quartz fiber filter (QFF) corresponding to each of the IITRI cartridge pairs was utilized at each sampling period. Five such filters were returned to the Research Triangle Institute for aerosol organics analysis. The IITRI cartridge pairs corresponding to these QFFs are shown in Table 9 (Note: one filter - #104 - does not correspond to any of the IITRI samples returned to our laboratories for analysis. This filter was nonetheless analyzed).

The analytical protocol for non-volatile, aerosol organics (Appendix D) involved Soxhlet extraction followed by fractionation of the extracted organics into 5 major fractions. These fractions were individually analyzed using GC/MS. Earlier results obtained for the analysis of the Hi-Vol filters not used in conjunction with the IITRI samplers showed very low levels of organics in each of the five fractions. Consequently for all but one of the Hi-Vol filters used with the IITRI samplers, the fractionation scheme was not employed, and the GFF extract was analyzed directly by GC/MS. The extract from filter number 89 (used in conjunction with IT1-4) was fractionated, with the results shown in Appendix F, as are the results from the other QFFs analyzed. As is evident from the diminished peak intensities from the TIC plots, and from the relatively few compounds identified, even from the non-fractionated extracts, the levels of non-volatile aerosol organics from these samples seem to be quite low. The other obvious result of these analyses is the presence of substantial levels of background components, principally phthalate esters and siloxanes. This aspect of Hi-Vol analysis is discussed more fully below under "Hi-Vol Samples".

TABLE 8. CONCENTRATION RANGES (ng/m^3) FOR SELECTED HALOGENATED HYDROCARBONS AS DETERMINED FOR THE HOUSTON AREA

Compound	Concentration (ng/m^3) Houston Area (this study)	Houston Area (ref 16)
Carbon tetrachloride	388-1922	69-11538
chloroform	236-685	1923-15384
1,2-dichloroethane	219	158-66300
trichloroethylene	1414-6786	39-5071
1,1,1-trichloroethane	79-216	144-27700

TABLE 9. HI-VOL FILTERS USED IN CONJUNCTION WITH SELECTED IITRI SAMPLES

Hi-Vol Filter No.	Corresponding IITRI Sample	Volume of Air Sampled (m^3)
89	1T1-4	766
90	1T1-2	911
104*	?	949
109	1T3-1	862
113	1T3-2	774

*Filter No. 104 was not used in conjunction with any of the IITRI samples received by RTI.

DICHOTOMOUS SAMPLES

Preliminary Studies

Prior to complete analysis of aerosol organics from the five dichotomous filters, the levels of background contaminants and their sources were determined. Using the analysis scheme as detailed in Appendix C, control runs were carried out to allow for the contribution of background components from the extraction solvent, from the dichotomous filter and from the extraction device utilized in the scheme. All operations for the control runs were identical to those used for the analysis of field samples.

Solvent background was determined by nitrogen blow-down of the volume of solvent (~ 8 mL) used for filter extraction, and analysis of residue by GC/MS. Filter contaminants were measured by the extraction and analysis of a filter blank. The background contribution of the extraction block was assessed by employing the complete analytical scheme without a filter.

The results of these control runs are depicted in Figure 13. The identities of the principal components are indicated on each chromatogram. The number of contaminants is acceptably low. Not unexpectedly, phthalate esters are present in the solvent; the only other major contaminant is an unsaturated hydrocarbon (octadecene) extracted from the extraction block. The relative retention time and mass spectral fragmentation patterns of all background compounds were noted for subsequent use during qualitative analysis of the field samples.

Qualitative Analysis

The results of the GC/MS analysis of the dichotomous filter extracts are shown in Appendix G. The number of components identified from each extract ranged from 25-43, of which a substantial portion was background contaminants. Phthalate esters and siloxanes were the major contaminants. Of those compounds identified as non-background materials, saturated and unsaturated hydrocarbons ($\sim C_{10}-C_{18}$) accounted for nearly all species. An alkylated phenol (C_9 and/or C_{10}) was also identified in each extract, presumably indicating a motor vehicle exhaust source for this compound. A summary of these results is presented in Table 10.

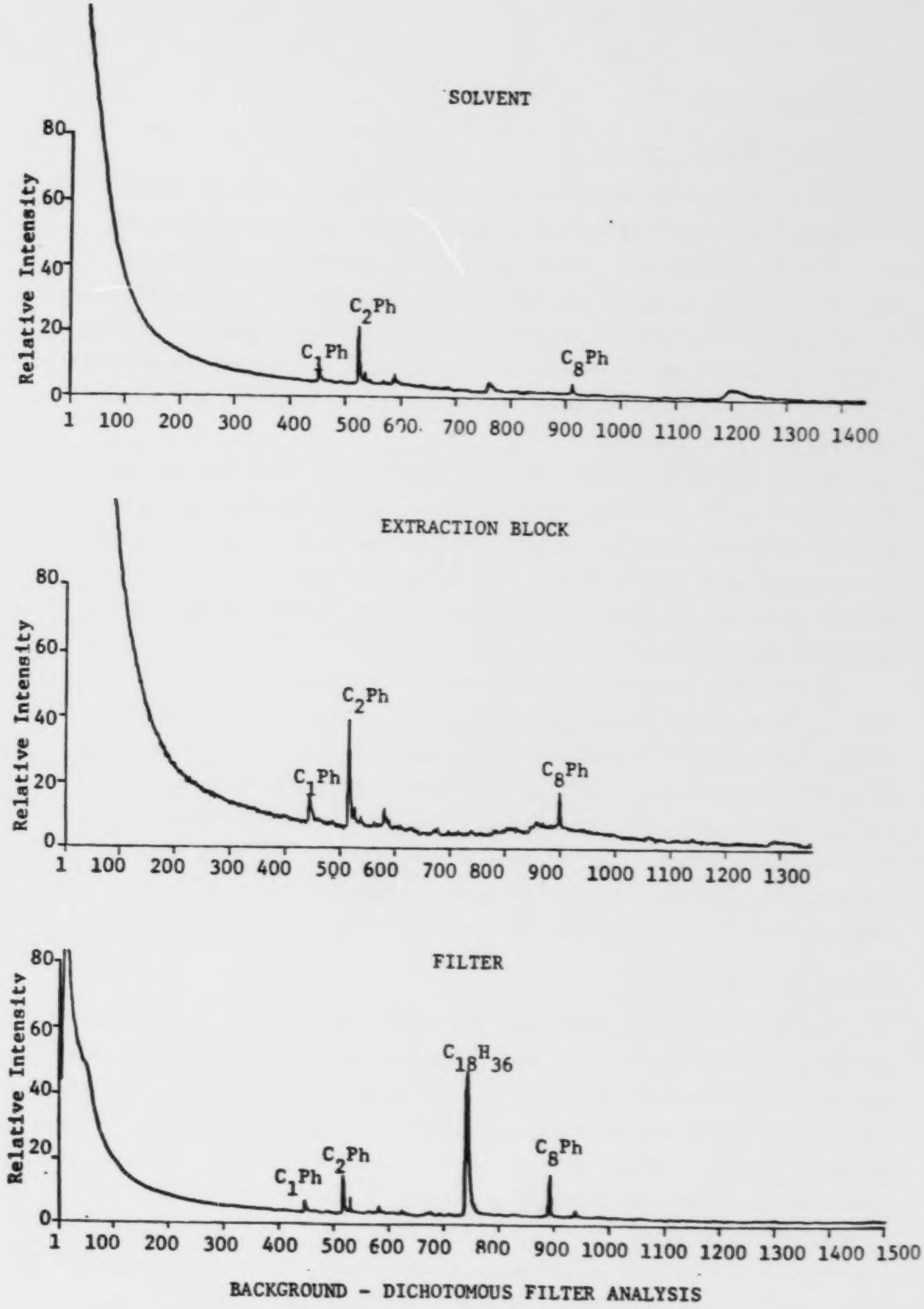

Figure 13. TIC - Dichotomous blank extracts.

TABLE 10. SUMMARY OF QUALITATIVE RESULTS FROM DICHOTOMOUS FILTER EXTRACTS

Filter No.	Total Peaks Identified	Background Components	Real Components	Composition of real components			
				Sat'd Hydrocarbons	Unsat'd Hydrocarbons	Alkyl Phenols	unknowns
4F-011	25	10	15	8	2	1	4
4F-012	41	16	25	13	5	1	6
4F-018	42	16	26	11	8	2	5
4F-021	28	13	15	6	3	1	5
4F-022	25	8	17	12	1	1	3

Quantitative Analysis

The amount of aerosol collected on each dichotomous filter is quite low (∿ 100-2000 μg) compared to aerosol collection devices more commonly used for non-volatile organics analysis (6,17). Typical urban aerosol levels for a Hi-Vol sampler, for a 24 hr sampling period, range from ∿ 250-350 mg (7). From data compiled from dichotomous sampling at Houston during an earlier study (Mr. R. Stevens, personal communication), the average aerosol load was ∿ 350 μg/fine filter. If ∿ 8% of this mass exists as organic extractables (7), some 28 μg would be available for analysis. At 90% extraction efficiency from the filter, 70% recovery after concentration (See Section 6), and 10% removal for GC/MS injection (Appendix C), only approximately 2 μg of organics reach the chromatograph. Thus low-level components will not be present in quantities sufficient for full qualitative/quantitative treatment.

Of the materials that were characterized from the dichotomous filter extracts (Tables G-1 to G-5) roughly half were identified as non-background components. Of these 5-6 were present at levels that permitted quantitation. These compounds, all higher molecular weight along chain hydrocarbons plus nonylphenol, are shown in Table 11, along with the levels calculated using the procedures described in Appendix B.

The variation both qualitatively and quantitatively between extracts is small, and no trends were noted regarding sampling site or time of sampling. The levels of saturated hydrocarbons (C_{15}-C_{18}) were comparable to levels from other urban site (18,19) and slightly higher than levels found from non-urban sites (20).

HI-VOL SAMPLES

The quartz fiber filters (QFF) designated for analysis under this program were received approximately three months after field collection. They were stored and shipped by Radian Corporation as per protocol (Appendix A), and were stored at -20°C in our laboratories until analysis was initiated. Although it had been anticipated that a gravimetric determination

TABLE 11. QUANTITATIVE RESULTS FROM DICHOTOMOUS FILTER EXTRACTS

Compound	Filter			
	4F-001	4F-012	4F-018	4F-021
C_9-alkyl phenol isomer	60 ng (5.0 ng/m^3)	20 ng (1.7 ng/m^3)	20 ng (1.4 ng/m^3)	20 ng (1.7 ng/m^3)
n-pentadecane	70 ng (5.8 ng/m^3)	50 ng (4.2 ng/m^3)	50 ng (3.6 ng/m^3)	35 ng (2.9 ng/m^3)
n-hexadecane	90 ng (7.5 ng/m^3)	50 ng (4.2 ng/m^3)	100 ng (7.2 ng/m^3)	30 ng (2.5 ng/m^3)
n-heptadecane	100 ng (8.3 ng/m^3)	60 ng (5.0 ng/m^3)	100 ng (7.2 ng/m^3)	70 ng (5.8 ng/m^3)
n-octadecane	260 ng (21.7 ng/m^3)	80 ng (6.7 ng/m^3)		130 ng (10.8 ng/m^3)
octadecene & isomers		6620 ng (551.7 ng/m^3)		620 ng (51.6 ng/m^3)

of total collected aerosol would be made, tearing and loss of small but significant portions of the QFF during unpacking precluded such determinations. Following extraction the total mass of aerosol organics was determined; the results are shown in Table 12. The organic loads ranged from low to average in comparison with expected levels from urban aerosol (7).

In contrast to the amount of aerosol collected by the dichotomous sampler, the Hi-Vol sampler is capable of efficiently trapping approximately 200-500 times as much aerosol for a 24 hour sampling period. It is known from a large body of work (e.g., 7, 11, 18) that a wide variety of organic compounds are adsorbed to the air particulate. As the direct analysis of such a mixture is not practical owing to the large number of species present and the generally unfavorable GC behavior of some classes (e.g., acids, bases), a sample fractionation procedure was proposed for the organic extracts obtained from the Hi-Vol filters used in this study. This method of fractionation was developed for the analysis of coal gasification effluents (21) and has been successfully applied to other air aerosol extracts (9).

Qualitative Analysis

Analysis by glass capillary GC/MS was accomplished for each fraction from each QFF extract. The results are shown in Appendix H. Firm characterization proved difficult for all fractions because of the unexpected presence of large numbers and amounts of interfering substances. Coelution of the interfering species with the compounds of interest produced complicated MS fragmentation patterns, obscured sample components in some cases and effectively raised sensitivity limits. The problem was noted for virtually all Hi-Vol samples (no such interferences were seen for the IITRI or dichotomous samples), and investigations into the precise nature of the substances were made.

The analysis of a filter blank, carried out under conditions identical to those used for sample filters, produced the TIC chromatograms shown in Figures 14-18. Identification of the components from

TABLE 12. TOTAL ORGANICS EXTRACTED FROM HI-VOL FILTERS

Filter Number	Weight of Organics Extracted (mg)
12	8.5
13	5.2
14	7.3
15	14.1
65	23.1
66	24.3
91 (blank)	3.4

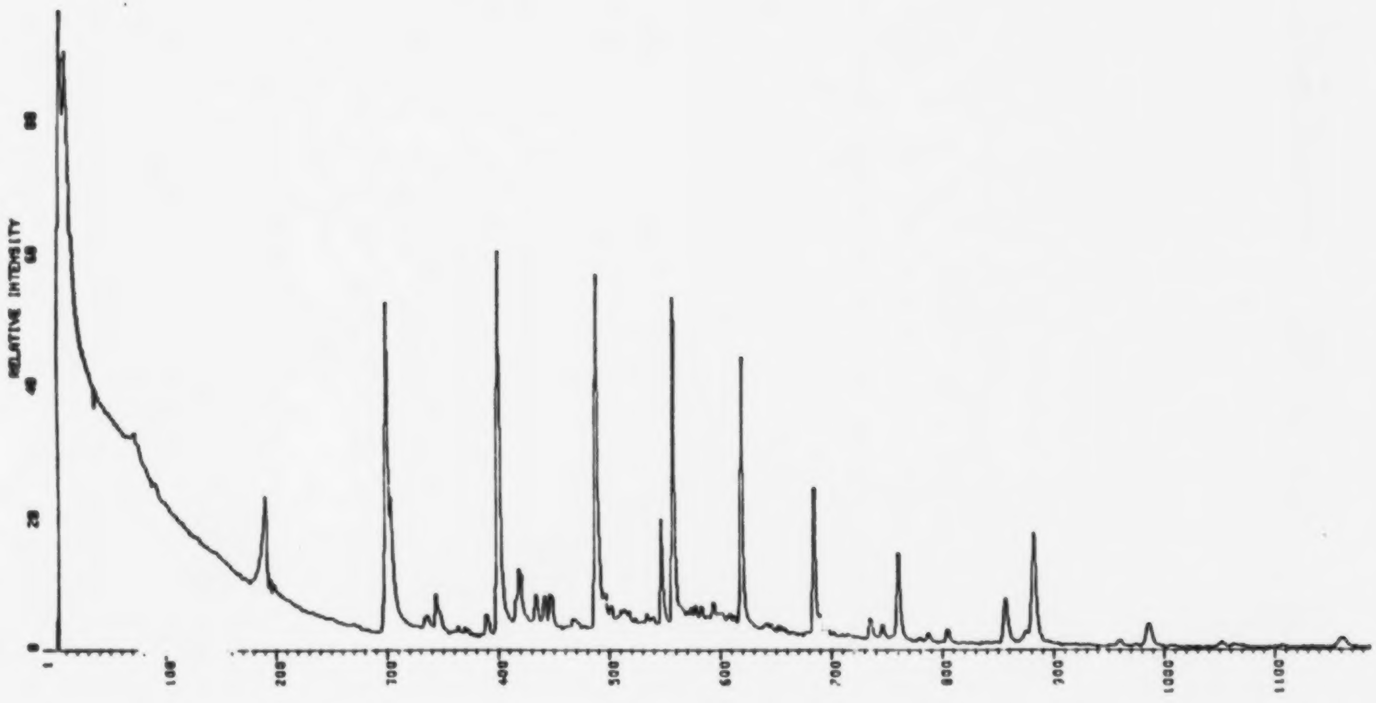

Figure 14. TIC - Filter blank, acid fraction.

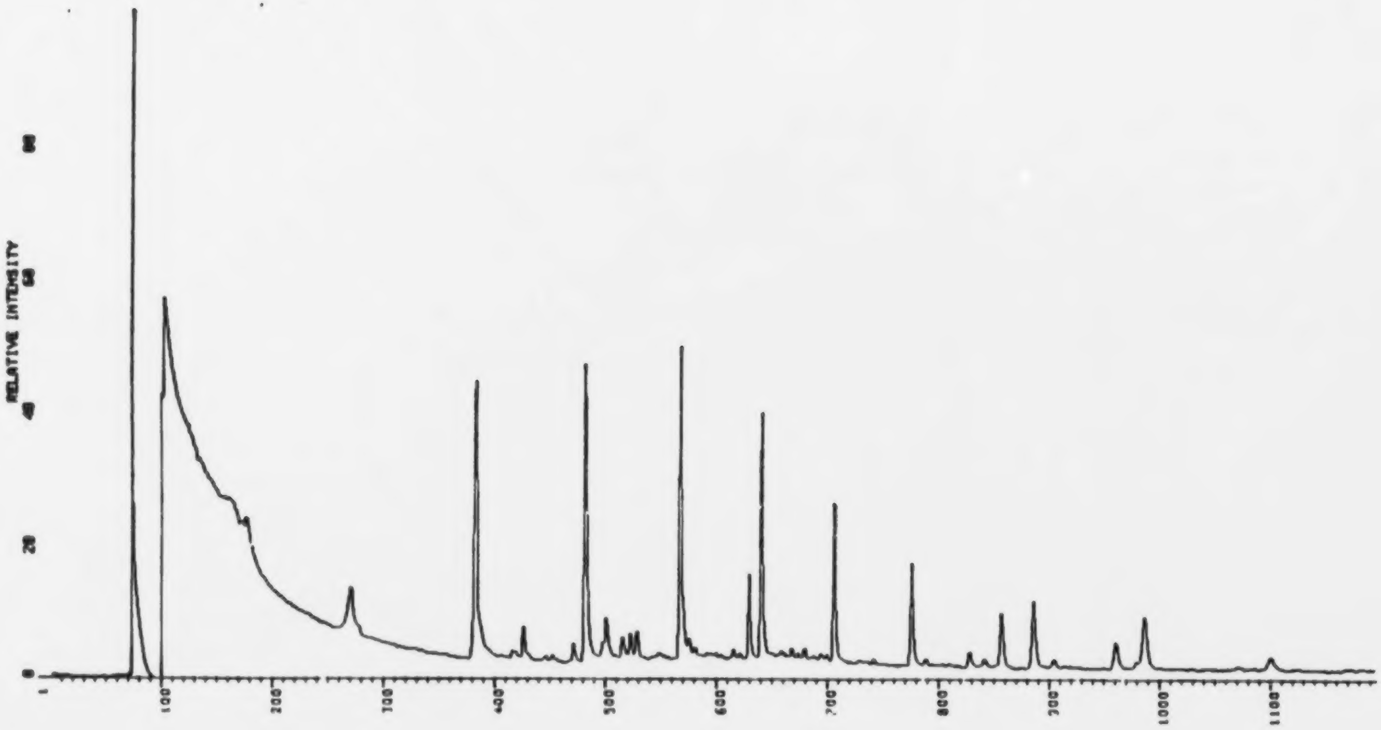

Figure 15. TIC - Filter blank, base fraction.

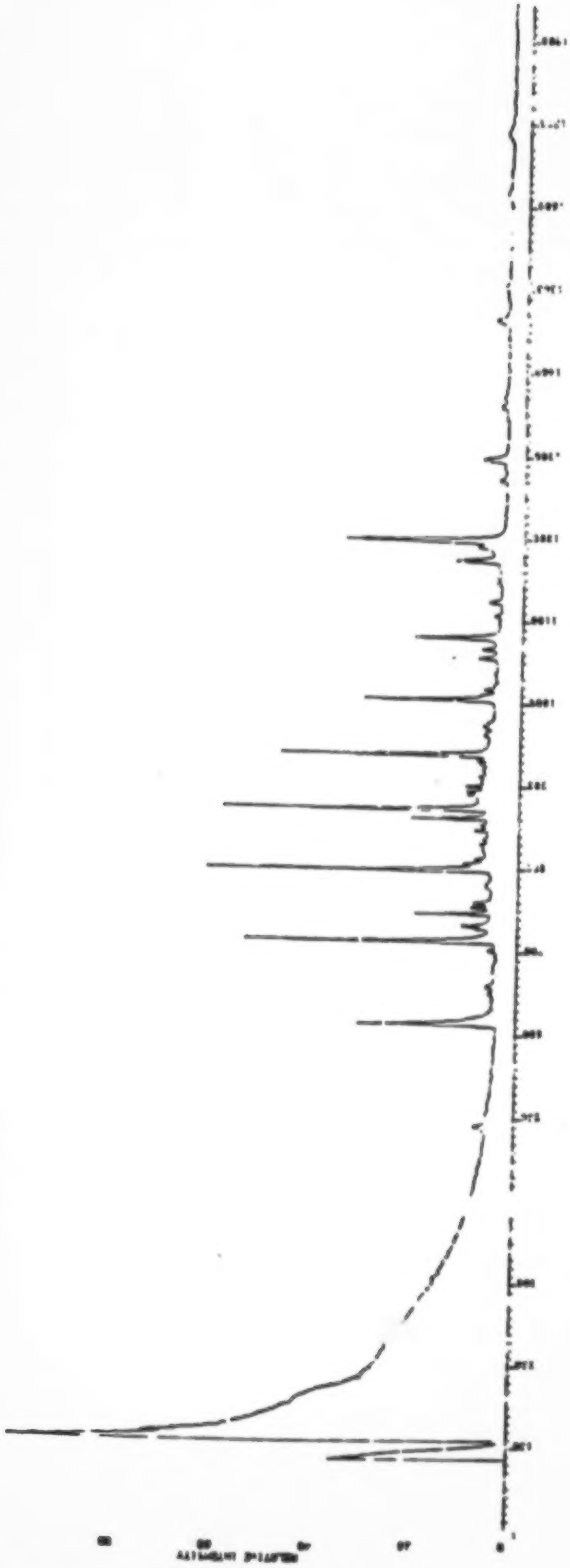

Figure 16. TIC - Filter blank, NPN fraction.

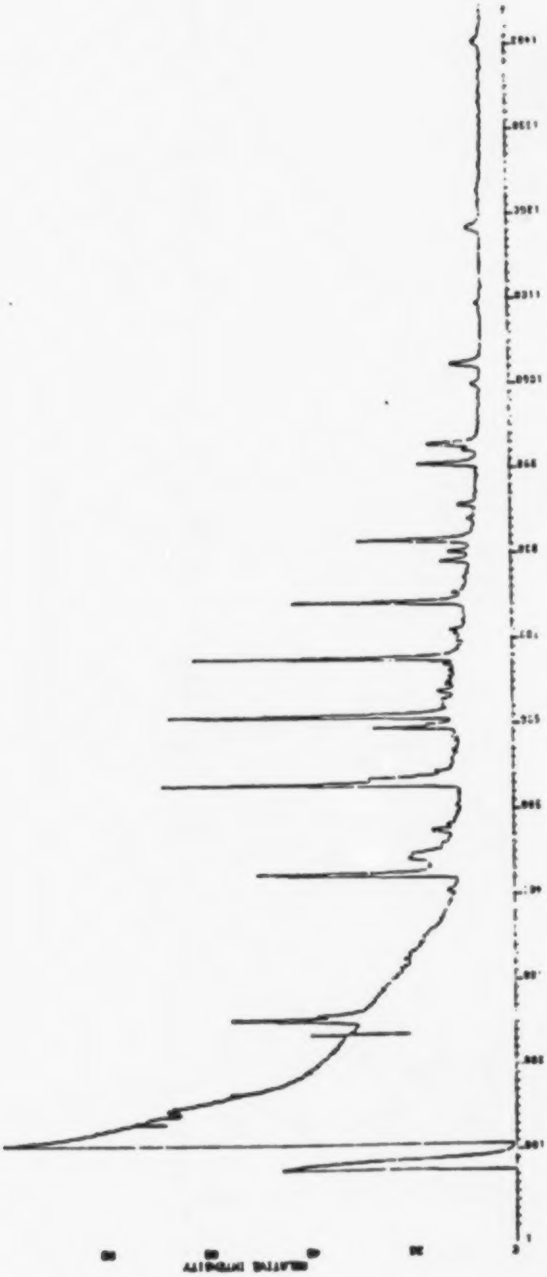

Figure 17. TIC - Filter blank, PNA fraction.

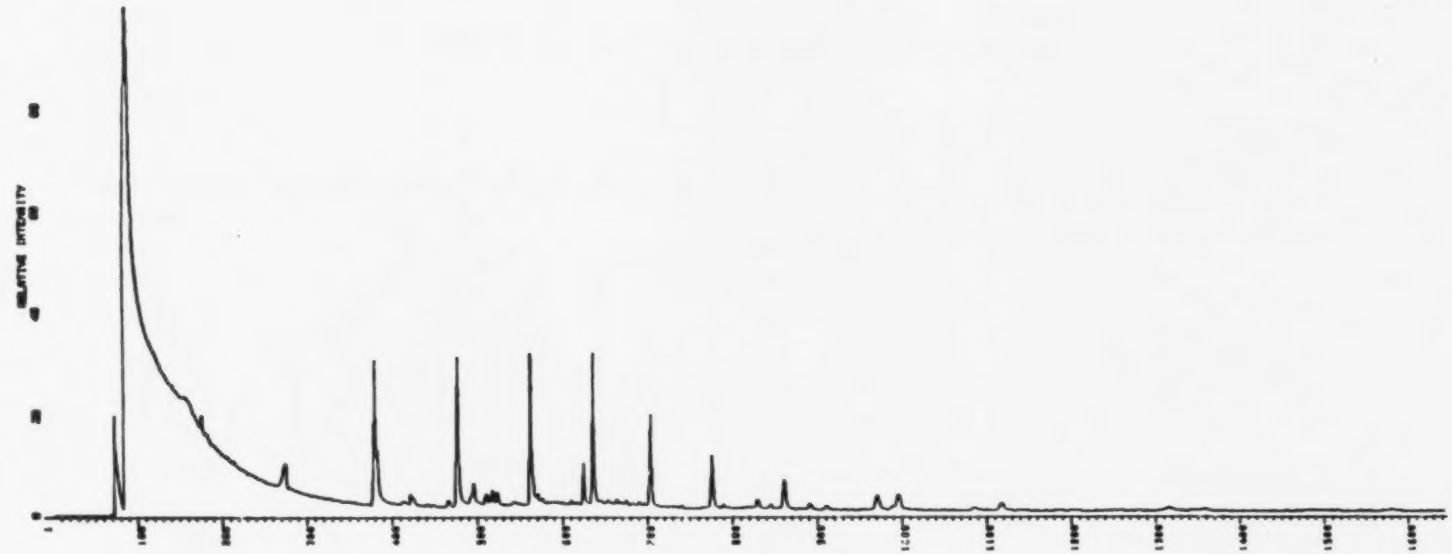

Figure 18. TIC - Filter blank, PN Fraction.

the sample filters (Tables H-1 to H-30) indicated the presence of a disproportionate number of phthalate esters and siloxanes of indeterminate structure. Both classes of compounds possess single ions that are characteristic of each compound type. As determined from a mass spectral catalog (ref. 8, Appendix B), virtually all phthalate esters possess an intense fragment ion at $\underline{m}/\underline{z}$ 149. This ion is a good indicator for phthalates since few other aerosol organics fragment in such a manner as to produce $\underline{m}/\underline{z}$ 149 of high intensity. For siloxanes, the most common, intense peak if found at $\underline{m}/\underline{z}$ 73, an ion that, while not unique to siloxanes, serves well for the rapid screening of samples for the possible presence of this class of materials. It is recognized that GC column bleed from columns employing silicone-based phases consists predominantly of siloxanes. This process is characterized by a relatively slow increase in GC baseline, and by the continuous presence throughout a long series of recorded mass spectra of background levels of siloxanes fragment ions. The siloxanes found associated with the Hi-Vol samples were identified as discrete and, for the most part, intense peaks, possessing mass spectra with fragment ion intensities much greater than is normally observed for column bleed. Thus, in addition to TIC chromatograms of the filter blank fractions (Figures 14-18), single ion plots ($\underline{m}/\underline{z}$ 73,149) were also obtained. The resulting chromatograms are shown in Figures 19-23. When compared with similar chromatograms obtained from the GC/MS analysis of a solvent control, where minimal $\underline{m}/\underline{z}$ 73,149 responses were noted (Figures 24-28), it would appear that the background components are associated with the filters utilized for sample collection. Although each quartz fiber filter was cleaned prior to field use, as noted earlier (Section 4) a great deal of variation in background contamination levels was observed, even for filters from the same lot. Further, the filter clean-up procedures as carried out in our laboratories showed that different solvent systems can be more effective than others for removing some contaminants. It is possible that the ether washing procedure used for the Hi-Vol filters in the Houston study, was not fully efficacious.

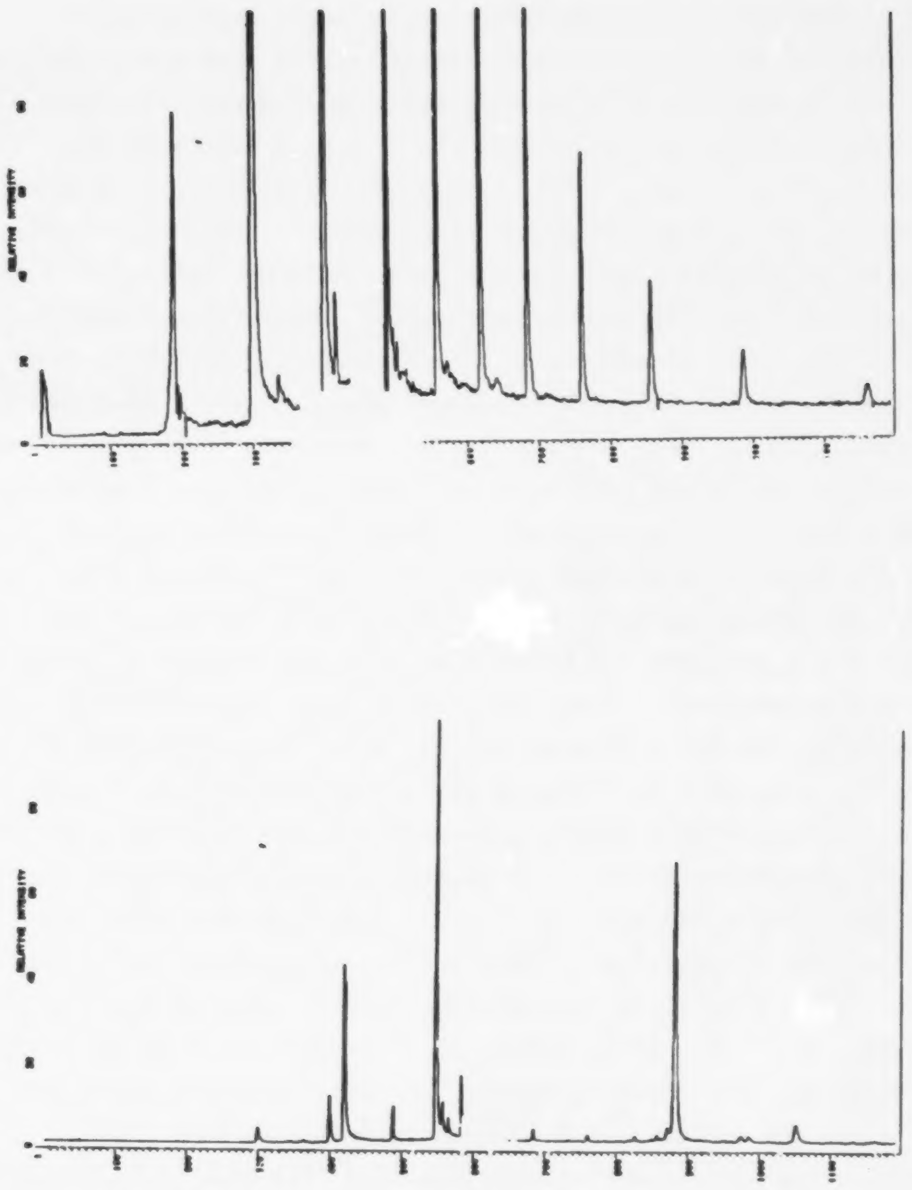

Figure 19. Single ion plot (m/z 73,149) for Hi-Vol filter (blank) - acid fraction.

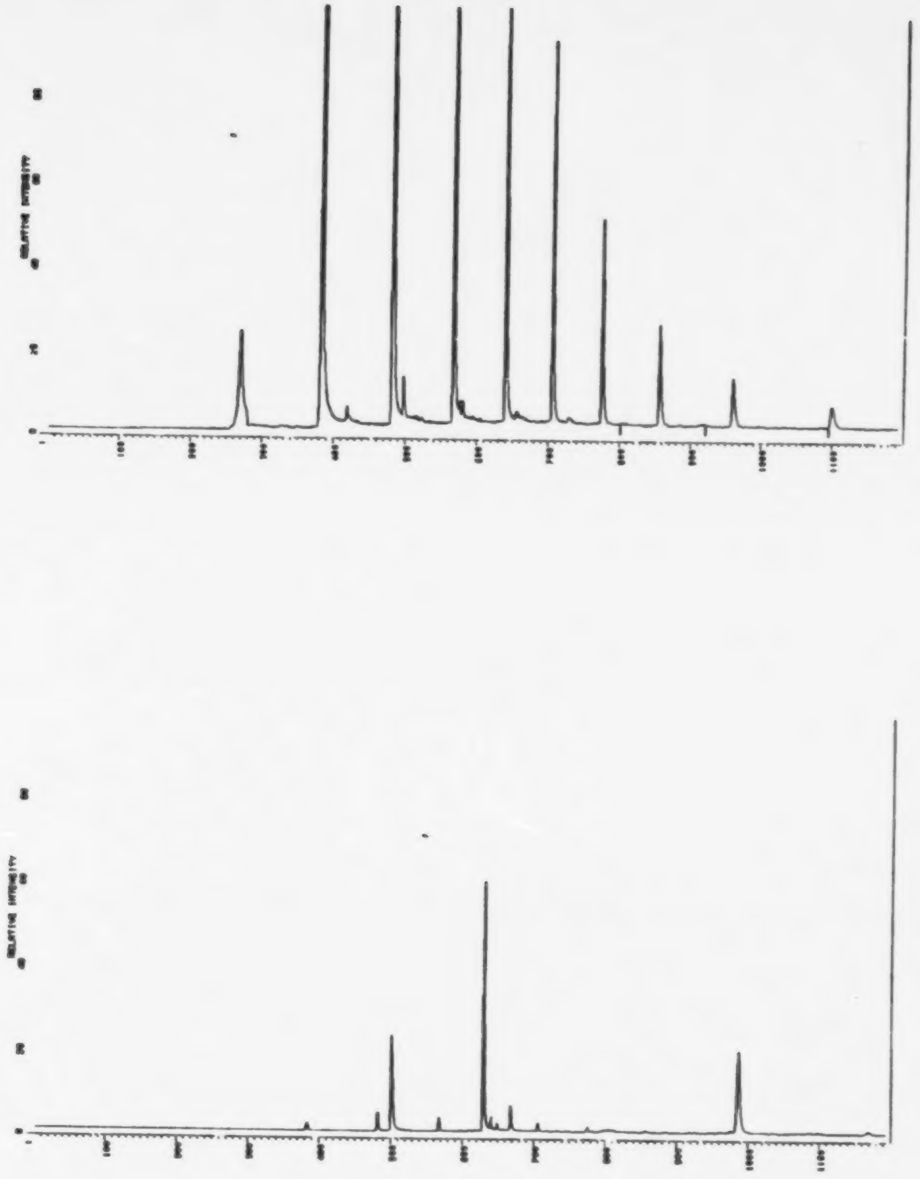

Figure 20. Single ion plot (m/z 73,149) for Hi-Vol filter (blank) - base fraction.

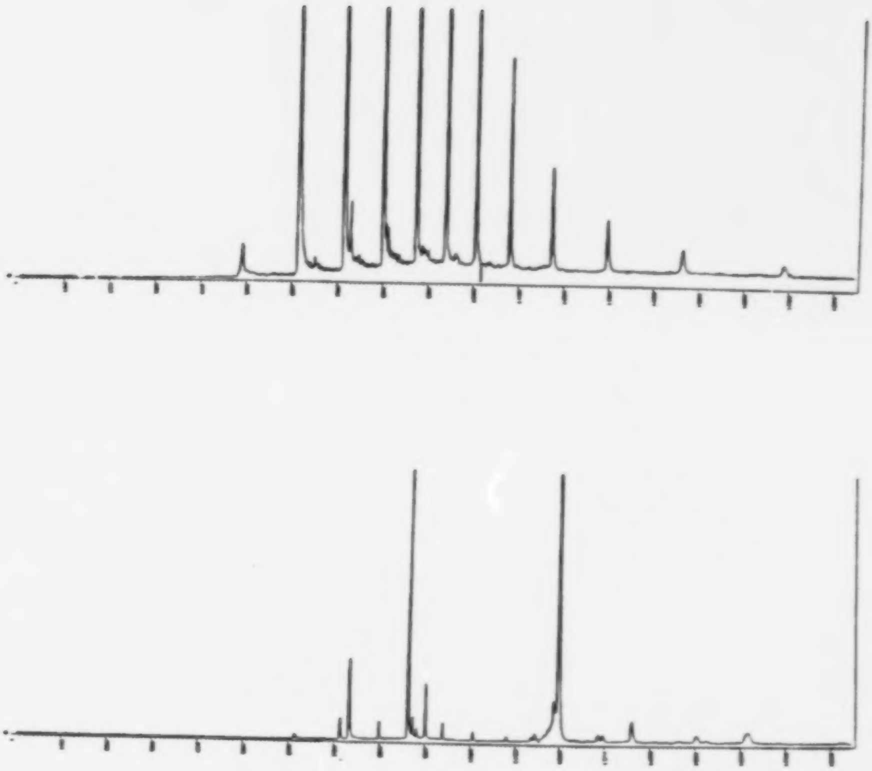

Figure 21. Single ion plot (m/z 73,149) for Hi-Vol filter (blank)-NPN fraction.

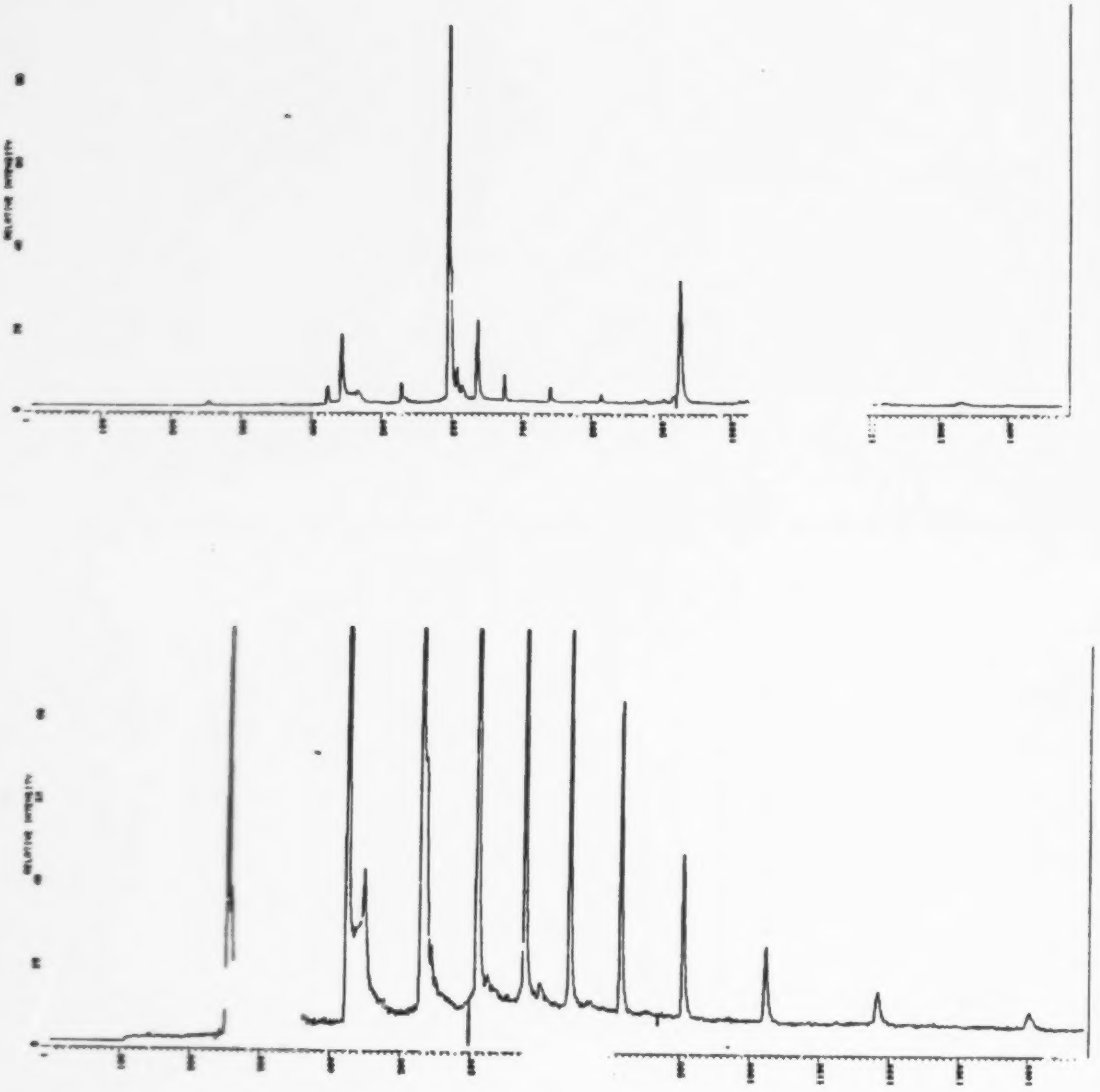

Figure 22. Single ion plot (m/z 73,149) for Hi-Vol filter (blank) - PNA fraction.

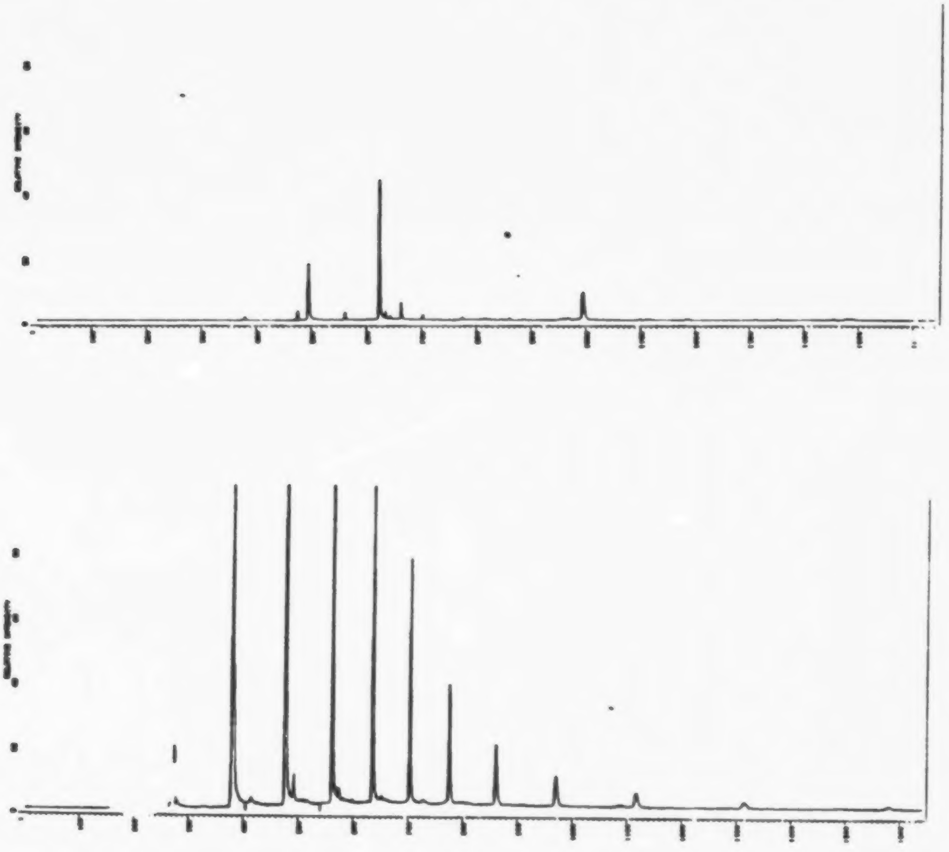

Figure 23. Single ion plot (m/z 73,149) for Hi-Vol filter (blank) - PN fraction.

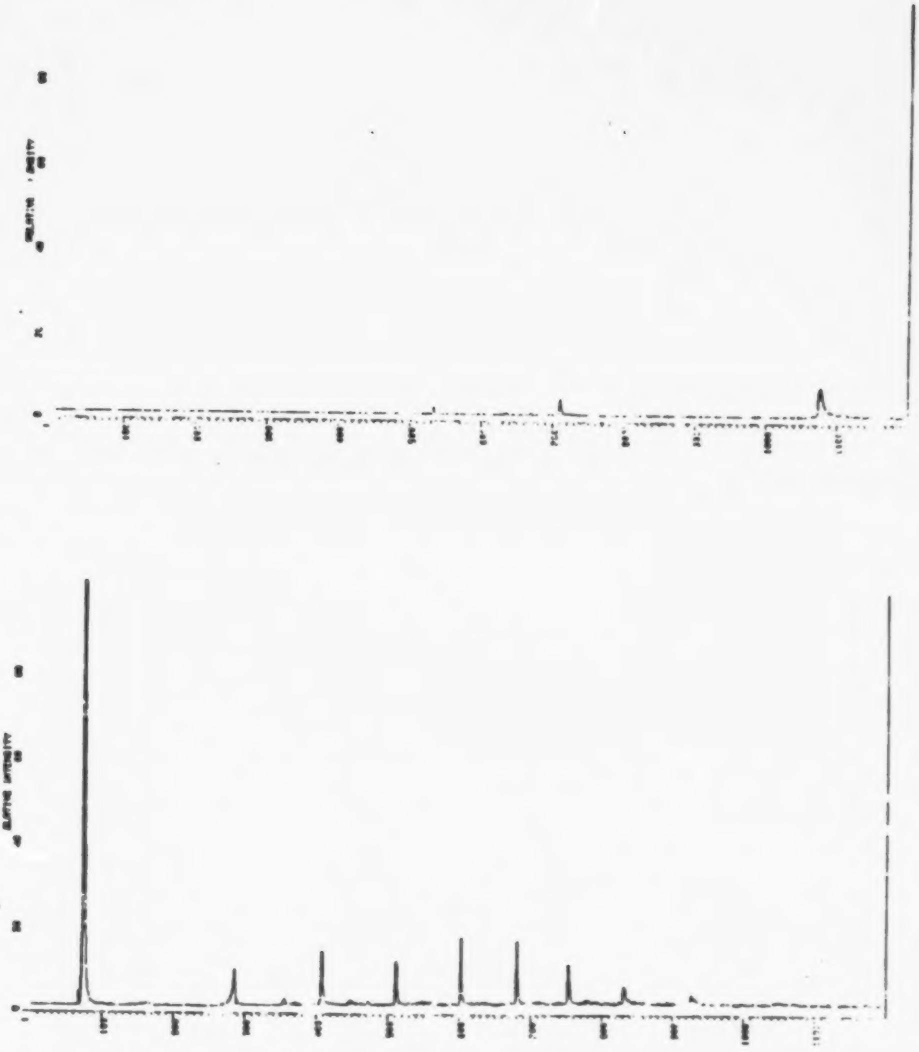

Figure 24. Single ion plot (m/z 73,149) for solvent control sample-acid fraction.

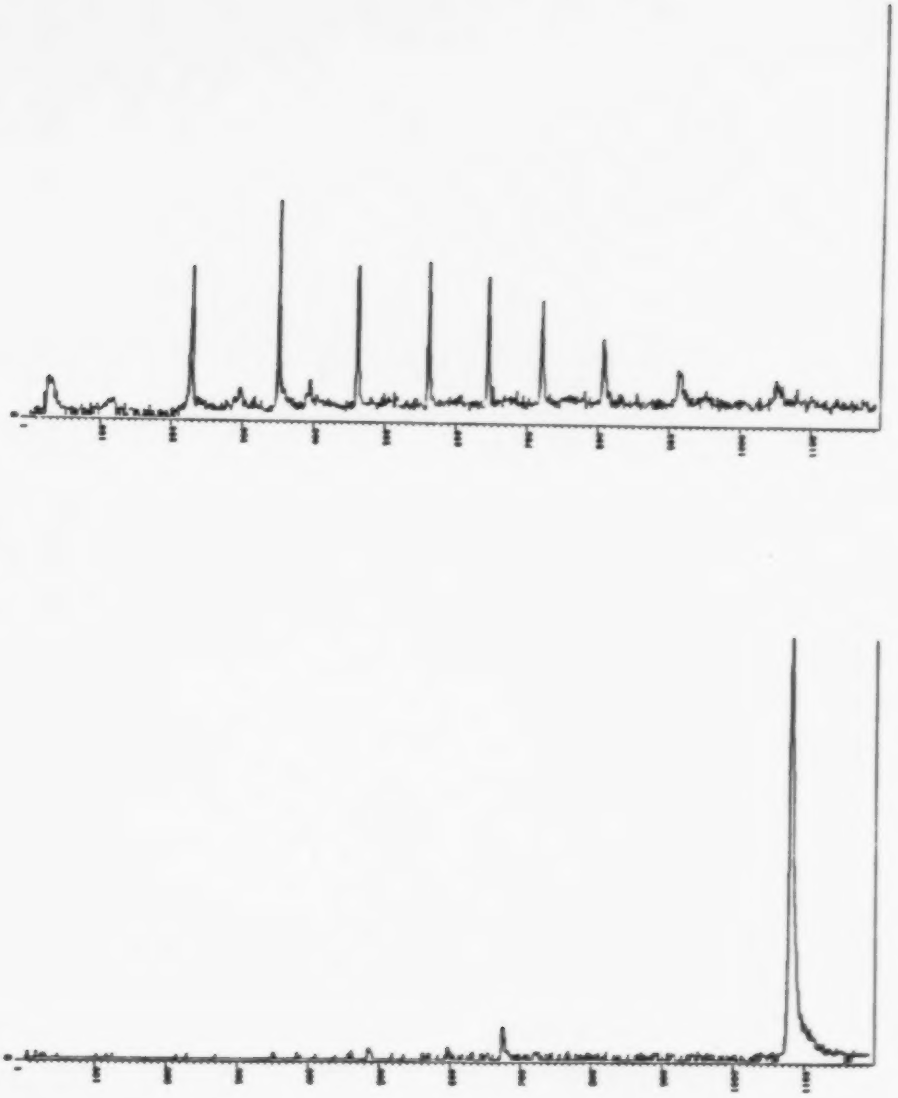

Figure 25. Single ion plot (m/z 73,149) for solvent control base fraction.

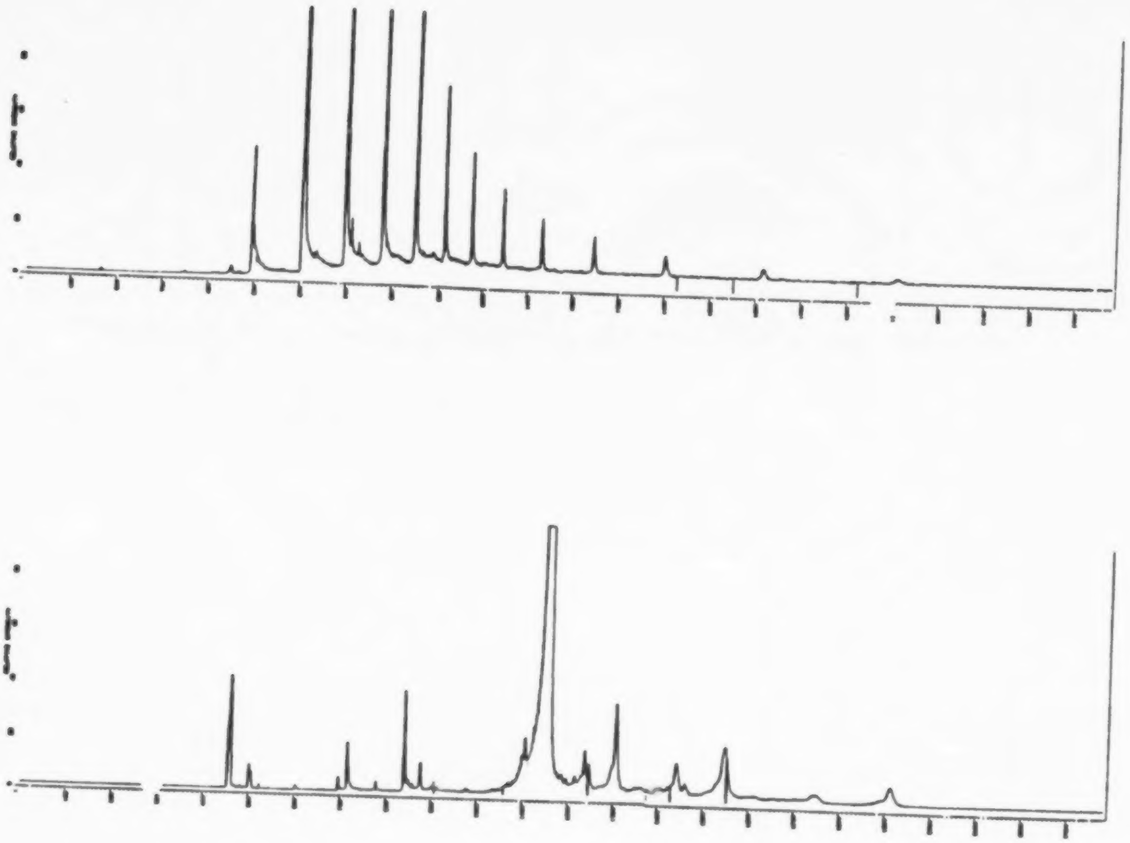

Figure 26. Single ion plot (m/z 73,149) for solvent control sample - NPN fraction.

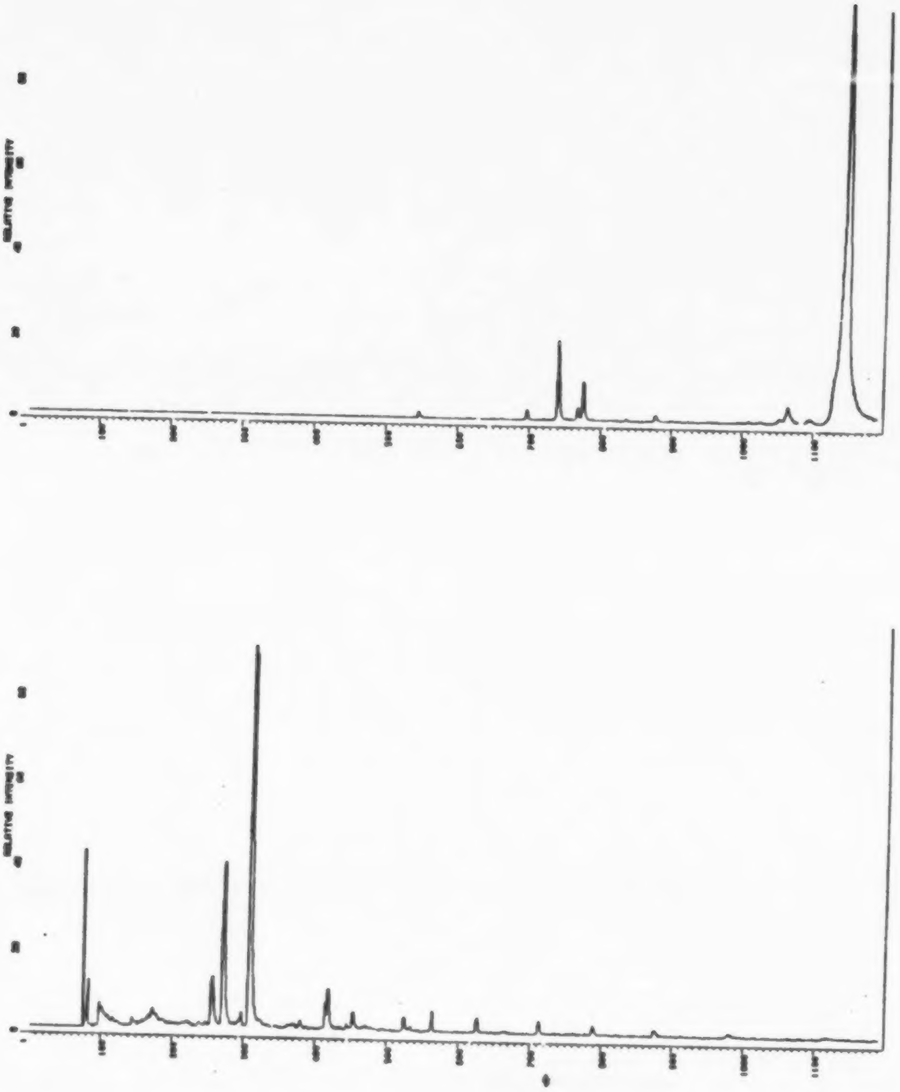

Figure 27. Single ion plot (m/z 73,149) for solvent control sample - PNA fraction.

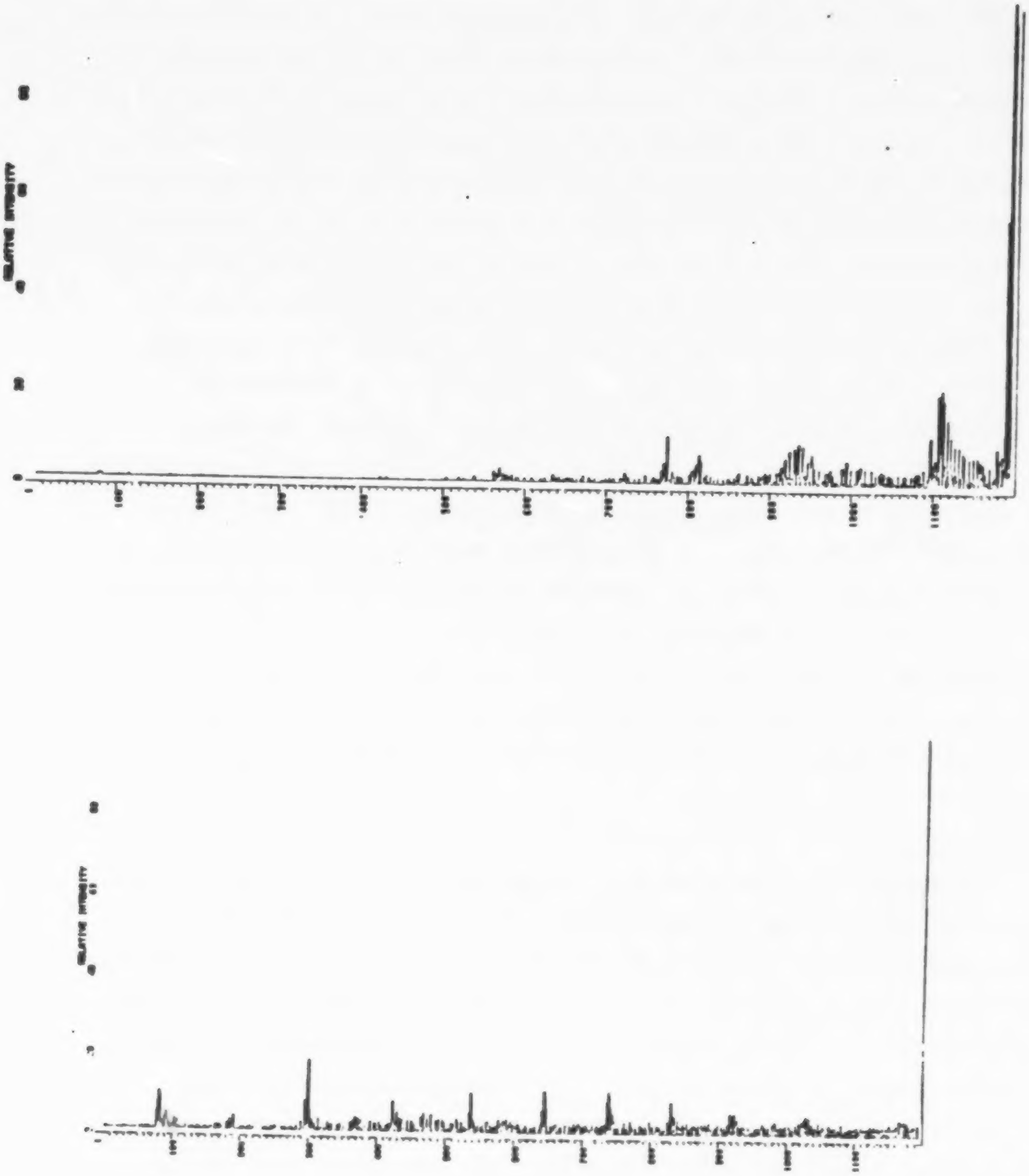

Figure 28. Single ion plot (m/z 73,149) for solvent control sample - PN fraction.

Other sources of background contamination were considered including the GC septa and silanized glass surface. Most septa are composed predominantly of silicone-based polymers. High temperature, exposure to solvent vapor clouds and repeated piercing by syringe needles are among those processes that could conceivably lead to the production of siloxanes. Silanized glass surfaces are commonly used in trace organic analysis systems, and are therefore also a likely source of siloxanes.

Both materials were examined and ruled out as siloxane sources. A GC septum of the type used in our laboratories was both solvent extracted and thermally desorbed, the latter process carried out as described for Tenax cartridges in Appendix B. Analysis by glass capillary GC/MS showed no significant levels of siloxanes or phthalates (as monitored by $\underline{m}/\underline{z}$ 73 & 149). In a like manner, silanized glass wool (silanized by treatment with dimethyldichlorosilane/toluene) was thermally desorbed (250°) and analyzed by GC/MS. Again no significant amounts of $\underline{m}/\underline{z}$ 73,149 material were observed.

From the evidence obtained, within the limits of funding and effort provided for this program, the background components, principally siloxanes and phthalate esters, appear to be associated with the QFF used in this study.

Quantitation

The analysis of extracts from the Hi-Vol filters showed generally low levels of organics, except for the above mentioned phthalate esters and siloxanes. At the direction of the Project Officer, quantitation was carried out only for saturated hydrocarbons. Based on the GC/MS behavior of C_{15}-C_{18} hydrocarbon standards, the relative molar responses (RMRs) of these compounds were shown to be very similar for $\underline{m}/\underline{z}$ 71, 99 and 113 (these ions are present in all saturated hydrocarbons). Thus average RMRs for each ion could be used for the quantitative determination of each compound possessing these chromatographic ions. Although any of three ions would suffice for quantitation, calculations based on all three ions were made, where possible, to detect interference from other compounds, and as a check on the overall method. Results for the non-polar neutral (NPN) fraction from three filters were obtained, and are shown in Tables 13-15. To calculate amounts of the individual compounds, determinations based on all three ions were averaged. If one determination was clearly deviant, i.e., if it differed by more than a factor of 2 from the other values, it was not used in the calculation of the average. It is recognized that the use of average RMRs for all hydrocarbons produces some uncertainty in final tabulations, and the figures obtained are best viewed as approximate. The paucity of material for filters 0014 and 0065, due in part to the lower volume of air sampled (~850 m^3 as compared to ~1050 for filter #0012), allowed for the quantitation of only 5 compounds.

For purposes of comparison, concentrations of selected aliphatic hydrocarbons were obtained from two sources, one (20) representing results of "clean" air; the other (18) representing results obtained from urban air. Both studies were conducted recently and are comprehensive and hence were chosen for comparison. Values for straight chain alkanes, C_{17}-C_{19} were available from each study. The comparison of data is shown in Table 16. Average hydrocarbon concentrations (for the alkanes chosen) from Houston aerosol are comparable to other urban levels, and are significantly higher than values obtained for "clean" air. It must be noted that the Houston data presented here are somewhat suspect because of the background contamination problem, the limited number of filters examined, and the method of estimation utilized. More rigorous methods of quantitation are clearly desirable.

TABLE 13. QUANTITATIVE DETERMINATION OF SATURATED HYDROCARBONS FROM HI-VOL EXTRACTS, NON-POLAR NEUTRAL FRACTION, FILTER #0012

	Amount (ng/m^3)			
Compound	m/z 71	m/z 99	m/z 113	Avg.
$C_{15}H_{32}$	-	8.4	7.9	8.2
$C_{16}H_{34}$	-	1.0	0.7	0.9
$C_{17}H_{36}$	-	-	1.4	1.4
$C_{18}H_{38}$	-	2.8	2.5	2.7
$C_{19}H_{40}$	0.7	2.1	1.1	1.3
$C_{20}H_{42}$	-	-	-	0.7
$C_{21}H_{44}$	1.7	1.5	0.9	1.4
$C_{22}H_{46}$	4.8	6.7	5.8	5.8
$C_{23}H_{48}$	5.2	6.2	6.5	6.0
$C_{24}H_{50}$	4.5	5.0	-	4.8
$C_{26}H_{54}$	3.9	7.1	6.3	5.8
$C_{28}H_{58}$	-	5.5	6.4	6.0
$C_{30}H_{62}$	2.0	3.2	-	2.6
$C_{33}H_{68}$	-	5.9	3.1	4.5
				Total 52.1

TABLE 14. QUANTITATIVE DETERMINATION OF SATURATED HYDROCARBONS FROM HI-VOL EXTRACTS, NON-POLAR NEUTRAL FRACTION, FILTER #0014

Compound	Amount (ng/m^3) m/z 71	m/z 99	Avg.
$C_{17}H_{36}$	1.7	2.1	1.9
$C_{18}H_{38}$	2.4	2.7	2.6
$C_{19}H_{40}$	-	-	1.2
$C_{22}H_{46}$	-	0.6	0.6
$C_{23}H_{48}$	4.7	-	4.7
		Total	11.0

TABLE 15. QUANTITATIVE DETERMINATION OF SATURATED HYDROCARBONS FROM HI-VOL EXTRACTS, NON-POLAR NEUTRAL FRACTION, FILTER #0065

Compound	Amount (ng/m^3) m/z 71	m/z 99	Avg.
$C_{12}H_{26}$	5.4	4.0	4.7
$C_{17}H_{36}$	-	8.0	8.0
$C_{18}H_{38}$	2.4	-	2.4
$C_{20}H_{42}$	2.6	-	2.6
$C_{21}H_{44}$	3.4	-	3.4
		Total	21.1

TABLE 16. COMPARISON OF CONCENTRATIONS OF SELECTED HYDROCARBONS

	Concentrations (ng/m^3)		
	Houston study*	"clean" air (ref. 20)†	urban air (ref. 18)
heptadecane	1.4-8.0 (3.8)	.12	1.4
octadecane	2.4-2.7 (2.6)	.18	1.1
nonadecane	1.2-1.3 (1.3)	.17	1.4

*Values shown include the range and, parenthetically, the mean.

†"clean" air = pure, tropospheric marine air.

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APPENDIX A

SUGGESTED SAMPLING PROTOCOL

Hi-Vol Protocol

Hi-Vol sampling will consist of 24 hr sampling periods using a minimum sampling rate of 1.4 m^3/min.

Filter Storage: After sampling, each quartz fiber filter should be individually wrapped in clean aluminum foil. The foil should be folded in such a way as to seal the filter (no tape should be used). The foil wrapped filters should then be tightly rolled about 8" axis, placed in clean glass jars and capped with Teflon-lined screw caps. They should be stored over dry ice until returned to the laboratory where they should be stored under refrigeration.

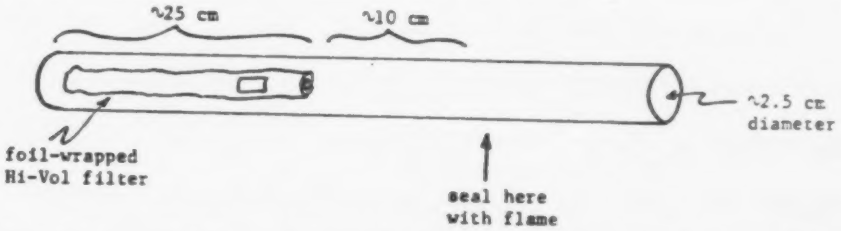
Filter Tare: Quartz fiber filters should be weighed prior to sampling. Tare weight determination should be made only after equilibration of the filters in a constant humidity atmosphere. This can be achieved by storage of the filters for 24 hrs in a dessicator charged with fresh, activated, indicator silica gel. A four place balance is suggested for weighing. A balance calibration weight will be provided to Radian for interlab balance calibration purposes. Thus the calibration weight should be weighed and the weight recorded during the filter taring process. The weight should then be shipped to RTI for weight deterination using the RTI balance. The weight should be kept clean and only handled with forceps.

Filter Labeling: Each filter, after removal from the Hi-Vol sampler, should be wrapped in foil. A label containing the filter code number should be attached to the filter pack with clear tape. The label should be filled out with a graphite pencil - ink should not be used.

Filter Coding: A code number should appear on the filter label. This number can be of Radian's choosing and should appear on the Hi-Vol data sheet that corresponds to the filter.

Data Sheet: For each filter, including blanks, a data sheet provided by RTI should be filled out as completely as possible. A sample form accompanies this protocol. It is important that this sheet contain the filter number in the space provided. The data sheet should be returned to RTI under separate cover.

Filter Shipment: Each foil-wrapped filter, when ready for shipment to RTI, shall be sent in sealed glass tubes. The tubes should contain only the foil-wrapped filter and filter label. The glass tube shall be large enough to contain the filter pack when rolled to approximately 2.5 cm diameter. The tube shall be closed at one end, the filter pack and label inserted, and the tube sealed at the other end with a flame. It is important that the tube be sealed a reasonable distance from the filter pack to avoid the effects of the flame. A distance of approximately 10 cm from filter to sealing point is suggested. Tube dimensions are shown below based on a trial effort in our labs:



A sample tube containing a wrapped, labeled filter will be provided to Radian prior to anticipated shipment dates.

Once sealed, the tube should then be safely packed in a rigid container for shipment via Federal Express to RTI.

Dichotomous Protocol

This protocol was developed by the Field Measurement Instrumentation Branch of ESRL-EPA in collaboration with RTI personnel. Five samplers will be utilized for the Houston study. These include two Beckman automatic dichotomous samplers (ADS) stationed at fixed sites, two Beckman ADS with sample cooling and N_2 gas purge stationed in Radian mobile laboratories, and one Lawrence Berkley Livermore (LBL) ADS in the EPA-IPAB mobile van. The Beckman ADS will be loaded and run according to the Beckman manual. The LBL/ADS will be run according to the EPA-LBL manual.

Filter Tray Storage: The fine and corresponding coarse trays should be stored in Ziplock plastic bags with both EPA and RTI data sheets. The bags should be stored at approximately 0°C with nitrogen gas purge of the storage compartment if possible. The storage device should be cleaned, and have no history of storage of organic chemicals or foods.

Filter Tray Labeling/Coding: Each sample tray should be unambiguously labeled with a code number. This number can be of Radian's choosing, and should appear on the corresponding data sheet.

Data Sheet: For each filter tray (both coarse and fine) a data sheet provided by RTI should be filled out as completely as possible. A sample form accompanies this protocol. Data sheets for dichotomous samples are blue. It is important that this sheet contain the filter number in the space provided. The data sheet should be returned with the filter trays.

Filter Tray Shipment: The two Beckman ADS filter trays and their data sheets will be packed as follows: (1) a fine and the corresponding coarse filter tray will be packed in a plastic Ziplock bag, (2) the bag should be placed in a foamed-lined GSA "reusable fast pack", (3) the fast pack should be placed in an outer box and buffered with polyester fiber, and (4) the complete package should be securely taped.

The two Beckman cooled ADS filter trays and their data seets will be packed as follows: (1) the fine and corresponding coarse filter trays should be packed in a plastic Ziplock bag, (2) the bag should be placed in a specially adapted "freeze-safe" container which has filled with dry ice, and (3) the complete package should be securely taped. The LBL filter trays are handled by simply enclosing in a plastic Ziplock bag and packaging. These various packages will be hand-carried by EPA personnel or their designees to Research Triangle Park.

IITRI Protocol

The IITRI/Tenax GC sampling will consist of 24 hr sampling periods, utilizing a sampling rate governed by a critical orifice. The orifice, 2.8 ℓ/min, will be supplied to Radian with the IITRI samplers. A modified Hi-Vol sampling head will also be supplied to Radian to be used with the IITRI sampler. This head contains an entry port, situated below the filter screen, for a flow measuring device. If flow is measured elsewhere, this entry port must be closed during sampling.

Three IITRI samplers will be supplied to Radian already loaded with clean Tenax GC. Each sampler consist of four pairs of Tenax cartridges each pair being controlled by toggle valves for opening and closing during sampling. One pair of cartridges is to be exposed during each sampling period. The entire sampler will be returned to RTI upon completion of sampling.

Sample Storage: Each sampler will be used for two sample collections, one blank and one sample for each site. Between sample collection periods, and after sample collection and before shipment, the samplers should be stored at $\leq$ 0°C.

Sampld Coding: The samplers will be shipped with the Tenax GC already loaded into the sampler cartridges. Each sampler will bear a code number and each cartridge pair will also be coded. The combined sampler and cartridge pair numbers will serve as a sample code number. Thus, for a vapor sample collected at a given site using IITRI sampler #2, and using cartridge pair #4, the code number would appear as IT2-4 (IT for IITRI). This number should then be used on the appropriate data sheet.

Data Sheet: For each cartridge pair including blanks, a data sheet provided by RTI should be filled out as completely as possible. Data sheets for the IITRI samplers are green. A sample form accompanies this protocol. It is important that this sheet contains the sampler/cartridge pair code number in the space provided. The data sheets should be returned to RTI with the samplers.

Sampler Shipment: Each sampler when ready for shipment, should be returned to RTI via Federal Express. The same containers used for shipment of the samplers to Radian from RTI should be used for the return. The samplers should be returned to Dr. Sparacino.

APPENDIX B

ANALYSIS METHODS FOR VAPOR-PHASE ORGANICS IN AMBIENT AIR

ANALYSIS OF VOLATILE ORGANIC COMPOUND IN AMBIENT AIR

1.0 Principle of Method

Recovery of volatile organics from Tenax GC is accomplished by thermal desorption and purging with helium into a liquid nitrogen cooled nickel capillary trap (1-3) and then the vapors are introduced into a high resolution glass gas chromatographic column where the constituents are separated from each other (2,4). Characterization and quantification of the constituents in the sample are accomplished by mass spectrometry either by measuring the intensity of the total ion current signal or by mass fragmentography (2,5). The analysis system is shown in Figure D1.

2.0 Range and Sensitivity

The linear range for the analysis of volatile organic compounds depends upon two principal features. The first is a function of the breakthrough volume of each specific compound which is trapped on the Tenax GC sampling cartridge and the second is related to the inherent sensitivity of the mass spectrometer for each organic (2,6). Thus, the range and sensitivity are a direct function of each compound which is present in the original ambient air. The linear range for quantitation on the gas chromatograph/mass spectrometer/computer (GC/MS/COMP) is generally three orders of magnitude. Table D1 lists the overall theoretical sensitivity for some examples of volatile organics which is based on these two principles (6).

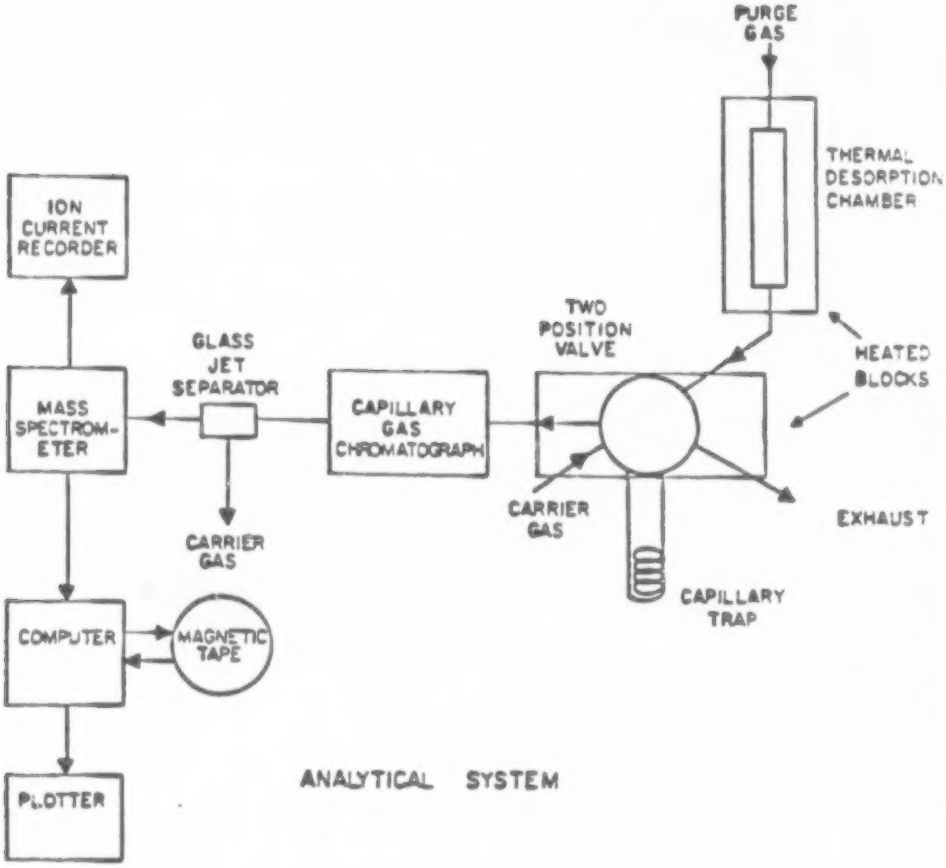

PURGE GAS
THERMAL DESORPTION CHAMBER
ION CURRENT RECORDER
TWO POSITION VALVE
HEATED BLOCKS
GLASS JET SEPARATOR
MASS SPECTROMETER
CAPILLARY GAS CHROMATOGRAPH
CARRIER GAS
EXHAUST
CARRIER GAS
CAPILLARY TRAP
COMPUTER
MAGNETIC TAPE
PLOTTER
ANALYTICAL SYSTEM

Figure B1. Analytical system for analysis of organic vapors in ambient air.

Table B1. OVERALL THEORETICAL SENSITIVITY OF HIGH RESOLUTION GAS CHROMATOGRAPHY/MASS SPECTROMETRY/COMPUTER ANALYSIS FOR ATMOSPHERIC POLLUTANTS

Chemical Class	Compound	Estimated Detection Limit[a]	
		ng/m^3	ppt
Halogenated hydrocarbon	Vinyl bromide	250	57
	Bromoform	0.340	0.03
	Bromodichloromethane	1.300	0.22
	Dibromochloromethane	0.667	0.07
	1-Bromo-2-chloroethane	1.00	0.67
	Allyl bromide	5.00	1.04
	1-Bromopropane	5.200	1.06
	1-Chloro-3-bromopropane	0.150	0.01
	1-Chloro-2,3-dibromopropane	~0.100	<0.01
	1,1-Dibromo-2-chloropropane	~0.100	<0.01
	1,2-Dibromoethane	0.530	0.07
	1,3-Dibromopropane	~0.100	~0.01
	Epichlorohydrin (1-Chloro-2,3-epoxypropane)	9.600	2.50
	Epibromohydrin (1-Bromo-2,3-epoxypropane)	0.300	0.05
	Bromobenzene	0.100	0.02
	Methyl bromide	500	135
	Methyl chloride	2000	1000
	Vinyl chloride	800	333
	Methylene chloride	700	200
	Chloroform	200	420
	Carbon tetrachloride	250	400

(continued)

Table B1 (cont'd)

Chemical Class	Compound	Estimated Detection Limit[a]	
		ng/m^3	ppt
Halogenated hydrocarbon (cont'd)	1,2-Dichloroethane	32	8.15
	1,1,1-Trichloroethane	66	12.45
	Tetrachloroethylene	2.5	0.38
	Trichloroethylene	10	1.92
	1-Chloro-2-methylpropene	62	21.5
	3-Chloro-2-methylpropene	62	21.5
	3-Chloro-1-butene	83	28.8
	Allyl chloride	83	28.8
	4-Chloro-1-butene	38	13.2
	1-Chloro-2-butene	13	4.5
	Chlorobenzene	2.10	0.47
	o-Dichlorobenzene	1.00	0.06
	m-Dichlorobenzene	0.75	0.01
	Benzylchloride	0.65	0.01
Halogenated ethers	2-Chloroethyl ethyl ether	4.15	0.97
	Bis-(chloromethyl)ether	1.0	1.10
Nitrosamines	N-Nitrosodimethylamine	5.0	1.67
	N-Nitrosodiethylamine	3.0	0.74
Oxygenated hydrocarbons	Acrolein	~100	56.5
	Glycidaldehyde	~59	9.5
	Propylene oxide	~60	25.5

(continued)

Table B1 (cont'd)

Chemical Class	Compound	Estimated Detection Limit[a]	
		ng/m^3	ppt
Oxygenated hydrocarbons (cont'd)	Butadiene diepoxide	~20	6.7
	Cyclohexene oxide	~10	2.5
	Styrene oxide	2	0.415
	Acetophenone	~2	~0.415
	β-Propiolactone	~3	~1.2
Nitrogenous Compounds	Nitromethane	8	~2.4
	Aniline	3.0	0.78
Sulfur Compounds	Diethyl sulfate	~50	-
	Ethyl methane sulfate	~5.0	-

[a] Limits are calculated on the basis of the breakthrough volume for 2.2 g of Tenax GC, (at 70°F), capillary column performance and sensitivity of the mass spectrometer to that compound in the mass fragmentography mode of most intense ion.

3.0 Interferences

The potential difficulties with this technique are primarily associated with those cases where isomeric forms of a particular substance cannot be resolved by the high resolution chromatographic column and when the mass spectral fragmentation patterns of each of the isomers are identical. An example of such a problem is seen with the C_5-alkyl aromatics of which there are 53 isomers. As the number of carbon atoms increases in the hydrocarbons and aromatics, the number of potential isomers becomes increasingly large and difficult to completely resolve by gas chromatography and/or by their corresponding mass spectral fragmentation patterns. However, differentiation between the hydrocarbons, that is, alkanes, alkenes, aromatics, oxygenated, etc., can be accomplished.

4.0 Reproducibility

The reproducibility of this method has been determined to range from ±10 to ±30% of the relative standard deviation for different substances when replicate sampling cartridges are examined (4). The inherent analytical errors are a function of several factors: [1] the ability to accurately determine the breakthrough volume for each of the organic compounds identified; [2] the accurate measurement of the ambient air volume sampled; [3] the percent recovery of the organic from the sampling cartridge after a period of storage; [4] the reproducibility of thermal desorption for a compound from the cartridge and its introduction into the analytical system; [5] the accuracy of determining the relative molar response ratios between the identified substance and the external standard used for calibrating the analytical system; [6] the reproducibility of transmitting the sample through the high resolution gas chromatographic column; and [7] the day-to-day reliability of the MS/COMP system (1-7).

The accuracy of analysis is generally ±30% but depends on the chemical and physical nature of the compound (2,7).

5.0 Advantages and Disadvantages of the Method

The gas chromatograph/mass spectrometer interfaced with a jet separator is extremely sensitive and specific for the analysis of many volatile organic compounds in ambient air. High resolution gas chromatographic separation provides adequate resolution of the substances found in ambient air for their subsequent quantification. The combination of the high resolution gas chromatographic column and the selection of specific or unique ions representing the various compounds of interest identified in the air samples yields a relatively specific assay method for these compounds (1-7).

The retention of water by Tenax is low; its thermal stability is high and its background is negligible allowing sensitive analysis (1,2,4,7).

6.0 Apparatus

6.1 Gas Chromatographic Column

A 0.35 mm i.d. x 100 m glass SCOT capillary column coated with SE-30 stationary phase (or a similar column) is used for effecting the resolution of the volatile organic compounds (4). The capillary column is conditioned for 48 hrs. at 245° at 2.25 ml/min of helium flow.

A glass jet separator is employed to interface the glass capillary column to the mass spectrometer on the Varian MAT CH-7 GC/MS/COMP system The separator is maintained at 240°C (2,4).

6.2 Inlet Manifold

An inlet manifold for thermally recovering vapors trapped on Tenax sampling cartridges is used and is shown in Figure Bl (1-4).

6.3 Gas Chromatograph

A Varian 1700 gas chromatograph is used to house the glass capillary column and is interfaced to the inlet manifold on the Varian MAT CH-7 system. This analytical system is presented schematically in Figure Bl.

6.4 Mass Spectrometer/Computer

A Varian MAT CH-7 mass spectrometer capable of a resolution of 2,000 equipped with single ion monitoring capability is used in tandem with the Varian 1700 gas chromatograph and interfaced to a Varian 620/L computer (Figure B1).

7.0 Reagents and Materials

All reagents used are analytical reagent grade.

8.0 Procedure

8.1 Cleaning of Glassware

All glassware is washed in Isoclean/water, rinsed with deionized distilled water, acetone and air dried. Glassware is heated to 450-500°C for 2 hours to insure that all organic material has been removed prior to its use.

8.2 Collection of Volatile Organics in Ambient Air

For large sample volumes, it is important to realize that the total volume of air may cause the elution of compounds through the sampling tube if their breakthrough volume is exceeded. The breakthrough volumes of some of the volatile organics are shown in Table B2, (2,3,7). These breakthrough volumes have been determined by a previously described technique (2). The breakthrough volume is defined as that point at which 50% of a discrete sample introduced into the cartridge is lost. Although the identity of a compound during ambient air sampling is not known (therefore, also its breakthrough volume), the compound can still be quantified after identification by GC/MS/COMP once the breakthrough volume has subsequently been established. Thus, for calculating concentration, the last portion of the sampling period which represents the volume of air sampled prior to breakthrough is selected. For cases in which the identity of a volatile organic compound is not known until after GC/MS, the breakthrough volume is subsequently determined.

Previous experiments have shown that the organic vapors collected on Tenax GC sorbent are stable and can be quantitatively recovered from the cartridge samplers up to 4 weeks after sampling when they are tightly closed in cartridge holders and placed in a second container that can be sealed, protected from light and stored at 0°C (1,2).

8.3 Analysis of Samples

The instrumental conditions for the analysis of volatile organics on the sorbent Tenax GC sampling cartridge is shown in Table A3. The thermal desorption chamber and the six port Valco valve are maintained at 270° and 240°, respectively. The jet separator is maintained at 240°. The mass spectrometer is set to scan the mass range from approximately 20-350. The helium purge gas through the desorption chamber is adjusted to 15-20 mL/min. The nickel capillary trap on the inlet manifold is cooled with liquid nitrogen. In a typical thermal desorption cycle, a sampling cartridge is placed in the preheated desorption chamber

Table B2. TENAX GC BREAKTHROUGH VOLUMES FOR SEVERAL ATMOSPHERIC POLLUTANTS[1]

Chemical Class	Compound	b.p. (°C)	Temperature (°F)					
			50	60	70	80	90	100
Halogenated hydrocarbon	methyl chloride	-24	8	6	5	4	3	2.5
	methyl bromide	3.5	3	2	2	1	1	0.9
	vinyl chloride	13	2	1.5	1.25	1.0	0.8	0.6
	methylene chloride	41	11	9	7	5	4	3
	chloroform	61	42	31	24	18	13	10
	carbon tetrachloride	77	34	27	21	16	13	10
	1,2-dichloroethane	83	53	41	31	23	18	14
	1,1,1-trichloroethane	75	23	18	15	12	9	7
	tetrachloroethylene	121	361	267	196	144	106	78
	trichloroethylene	87	90	67	50	38	28	21
	1-chloro-2-methylpropene	68	26	20	16	12	9	7
	3-chloro-2-methylpropene	72	29	22	17	13	10	8
	1,2-dichloropropane	95	229	162	115	81	58	41
	1,3-dichloropropane	121	348	253	184	134	97	70
	epichlorohydrin (1-chloro-2,3-epoxypropane)	116	200	144	104	74	54	39
	3-chloro-1-butene	64	19	15	12	9	7	6
	allyl chloride	45	21	16	12	9	6	5
	4-chloro-1-butene	75	47	36	27	20	15	12
	1-chloro-2-butene	84	146	106	77	56	40	29
	chlorobenzene	132	899	653	473	344	249	181
	o-dichlorobenzene	181	1,531	1,153	867	656	494	372
	m-dichlorobenzene	173	2,393	1,758	1,291	948	697	510

(continued)

Table B2 (cont'd)

Chemical Class	Compound	b.p. (°C)	Temperature (°F)					
			50	60	70	80	90	100
Halogenated hydrocarbons (cont'd)	benzyl chloride	179	2,792	2,061	1,520	1,125	830	612
	bromoform	149	507	386	294	224	171	131
	ethylene dibromide	131	348	255	188	138	101	74
	bromobenzene	155	2,144	1,521	1,079	764	542	384
Halogenated Ethers	2-chloroethyl ethyl ether	108	468	336	241	234	124	89
	Bis-(chloromethyl)ether	-	995	674	456	309	209	142
Nitrosamines	N-nitrosodimethylamine	151	385	280	204	163	148	107
	N-nitrosodiethylamine	177	2,529	1,836	1,330	966	700	508
Oxygenated hydrocarbons	acrolein	53	19	14	10	8	6	4
	glycidaldehyde	-	364	247	168	114	77	52
	propylene oxide	34	35	24	17	11	8	5
	butadiene diepoxide	-	1,426	1,009	714	506	358	253
	cyclohexene oxide	132	2,339	1,644	1,153	811	570	400
	styrene oxide	194	5,370	3,926	2,870	2,094	1,531	1,119
	phenol	183	2,071	1,490	1,072	769	554	398
	acetopheonone	202	3,191	2,382	1,778	1,327	991	740
	β-propiolactone	57	721	514	366	261	186	132
Nitrogenous Hydrocarbons	nitromethane	101	45	34	25	19	14	11
	aniline	184	3,864	2,831	2,075	1,520	1,114	817
Sulfur Compounds	diethyl sulfate	208	40	29	21	15	11	8
	ethyl methane sulfate	86	5,093	3,681	2,564	1,914	1,384	998

(continued)

Table B2 (cont'd)

Chemical Class	Compound	b.p. (°C)	Temperature (°F)					
			50	60	70	80	90	100
Amines	dimethylamine	7.4	9	6	4	3	2	1
	isobutylamine	69	71	47	34	23	16	11
	t-butylamine	89	6	5	4	3	2	1
	di-(*n*-butyl)amine	159	9,506	7,096	4,775	3,105	2,168	1,462
	pyridine	115	378	267	189	134	95	67
	aniline	184	8,128	5,559	3,793	2,588	1,766	1,205
Ethers	diethyl ether	34.6	29	21	15	11	8	5
	propylene oxide	35	13	9	7	5	4	3
Esters	ethyl acetate	77	162	108	72	48	32	22
	methyl acrylate	80	164	111	75	50	34	23
	methyl methacrylate	100	736	484	318	209	137	90
Ketones	acetone	56	25	17	12	8	6	4
	methyl ethyl ketone	80-2	82	57	39	27	19	13
	methyl vinyl ketone	81	84	58	40	28	19	14
	acetophenone	202	5,346	3,855	2,767	2,000	1,439	1,037
Aldehydes	acetaldehyde	20	3	2	2	1	0.9	0.7
	benzaldehyde	179	7,586	5,152	3,507	2,382	1,622	1,101
Alcohols	methanol	64.7	1	1	0.8	0.6	0.4	0.3
	n-propanol	97.4	27	20	14	10	7	5
	allyl alcohol	97	32	23	16	11	8	6

(continued)

Table B2 (cont'd)

Chemical Class	Compound	b.p. (°C)	Temperature (°F)					
			50	60	70	80	90	100
Aromatics	benzene	80.1	108	77	54	38	27	19
	toluene	110.6	494	348	245	173	122	86
	ethylbenzene	136.2	1,393	984	693	487	344	243
	cumene	152.4	3,076	2,163	1,525	1,067	750	527
Hydrocarbons	*n*-hexane	68.7	32	23	17	12	9	6
	n-heptane	98.4	143	104	75	55	39	29
	1-hexene	63.5	28	20	15	11	8	6
	1-heptene	93.6	286	196	135	93	64	44
	2,2-dimethylbutane	49.7	0.5	0.4	0.3	0.2	0.2	0.1
	2,4-dimethylpentane	80.5	435	252	146	84	49	28
	4-methyl-1-pentene	53.8	14	10	8	6	4	3
	cyclohexane	80.7	49	36	26	19	14	10
Inorganic gases	nitric oxide	-	0	0	0	0	0	0
	nitrogen dioxide	-	0	0	0	0	0	0
	chlorine	-	0	0	0	0	0	0
	sulfur dioxide	-	0.06	0.05	0.03	0.02	0.02	0.01
	water	100	0.06	0.05	0.04	0.03	0.01	0

[a] Breakthrough volume is given in ℓ/2.2 g Tenax GC used in sampling cartridges.

Table B3. OPERATING PARAMETERS FOR GLC-MS-COMP SYSTEM

Parameter	Setting
Inlet-manifold	
desorption chamber and valve	270°C
capillary trap - minimum	-195°C
maximum	240°C
thermal desorption time	8 min
He purge flow	15 ml/min
GLC	
100 m glass SCOT SE-30	25-240°C, 4°C/min
carrier (He) flow	~3 ml/min
MS Varian MAT CH-7	
scan range	$\underline{m}/\underline{z}$ 20 → 350
scan cycle, automatic-cyclic	$\underline{1}$ sec/decade
filament current	300 μA
multiplier	4.0
ion source vacuum	~4 x 10^{-6} torr

and the helium gas is channeled through the cartridge to purge the vapors into the liquid nitrogen capillary trap [the inert activity of the trap has been shown in a previous study (4)]. After the desorption has been completed, the six-port valve is rotated and the temperature on the capillary loop is rapidly raised (greater than 10°/min); the carrier gas then introduces the vapors onto the high resolution GC column. The glass capillary column is temperature programmed from ambient to 240°C at 4°C/min and held at the upper limit for a minimum of 10 min. After all the components have eluted the column is then cooled to ambient temperature and the next sample is processed (2).

An example of the analysis of volatile organics in ambient air is shown in Figure B2 and the background from a blank cartridge is shown in Figure B3. The high resolution glass capillary column was coated with SE-30 stationary phase which is capable of resolving a multitude of compounds to allow their subsequent identification by MS/COMP techniques; in this case over 110 compounds were identified in this chromatogram.

8.3.1 Operation of the MS/COMP System (Figure B4)

Typically the Varian MAT CH-7 mass spectrometer is first set to operate in the repetitive scanning mode. In this mode the magnet is automatically scanned exponentially upward from a preset low mass to a high mass value. Although the scan range may be varied depending on the particular sample, typically the range is set from approximately m/z 20 to m/z 350. The scan is completed in approximately 1.8 seconds. At this time the instrument automatically resets itself to the low mass position in preparation for the next scan, and the information is accumulated by an on-line 620/L computer and written onto magnetic tapes. The

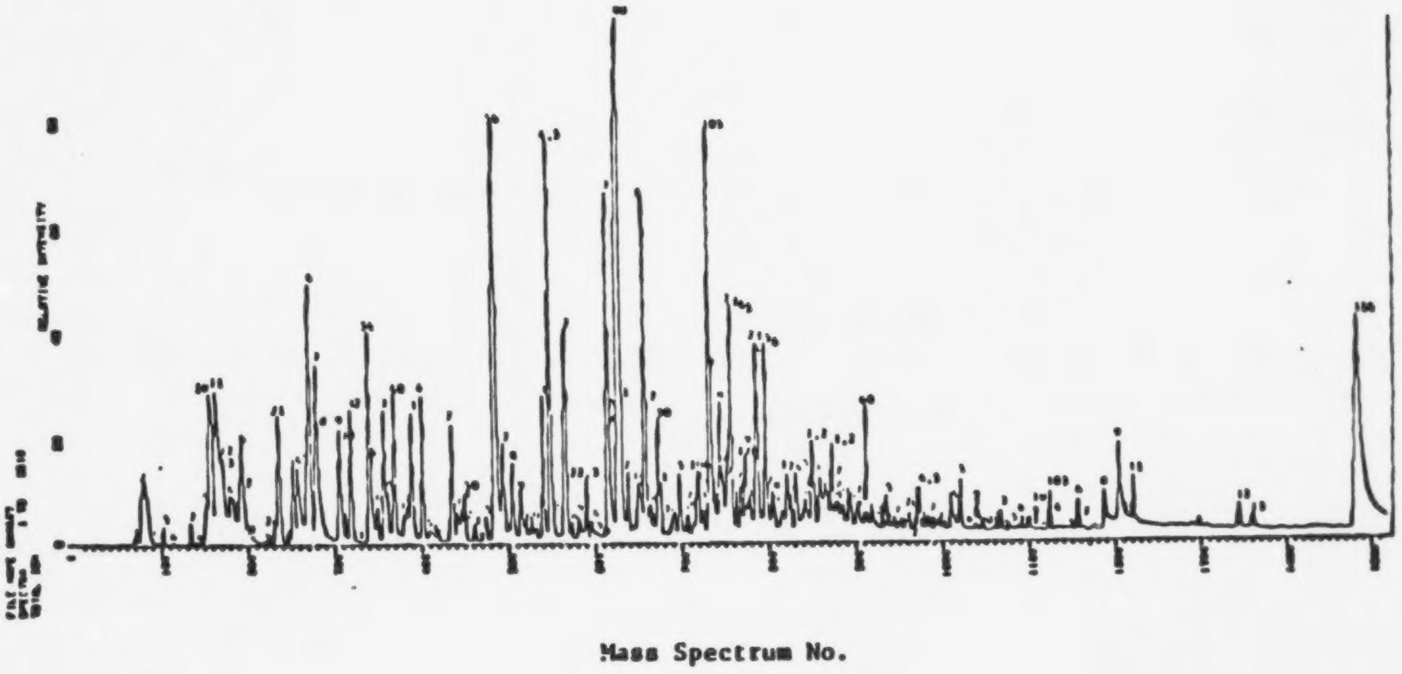


Figure B2. Profile of ambient air pollutants obtained using high resolution gas chromatography/mass spectrometry/computer.

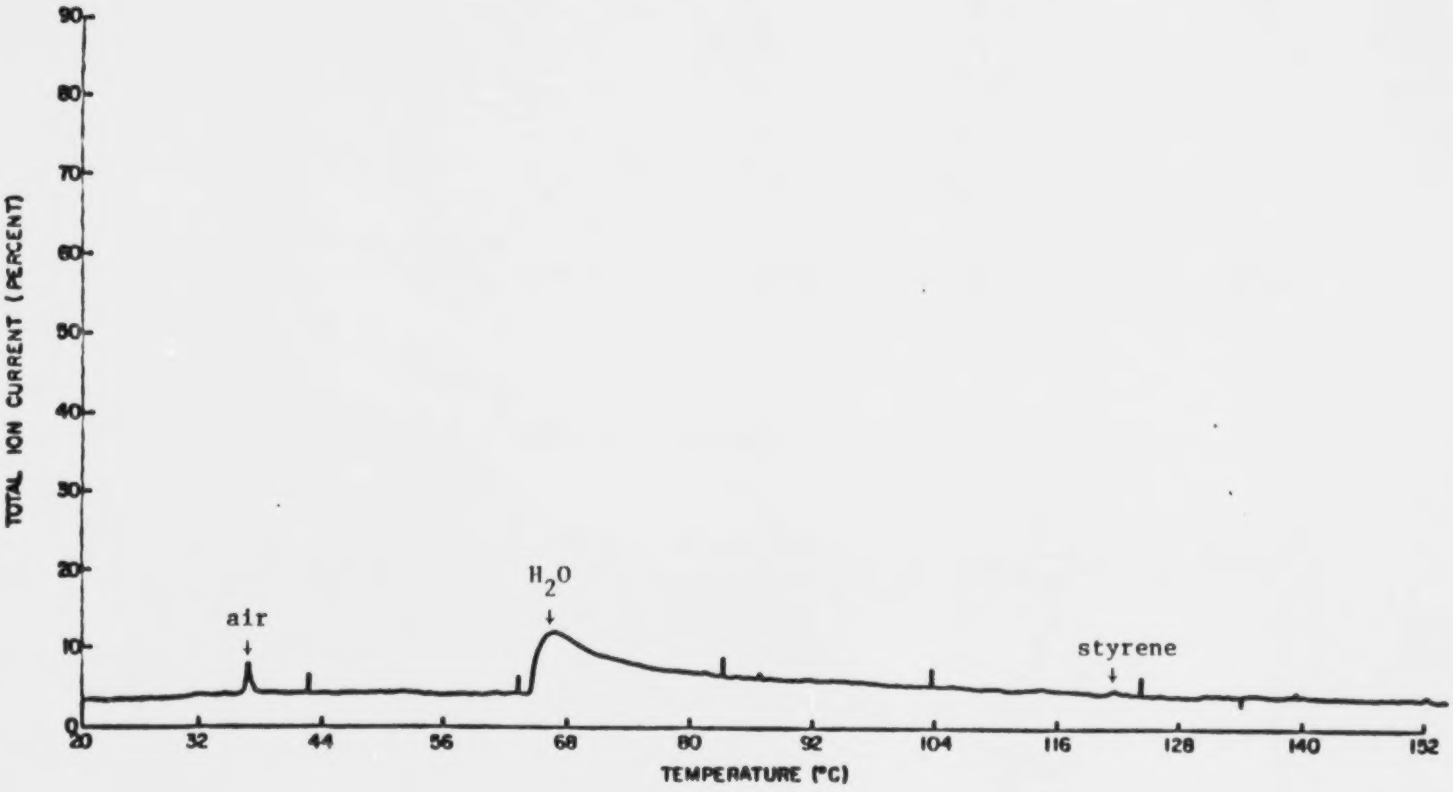


Figure B3. Background profile for Tenax GC cartridge blank.

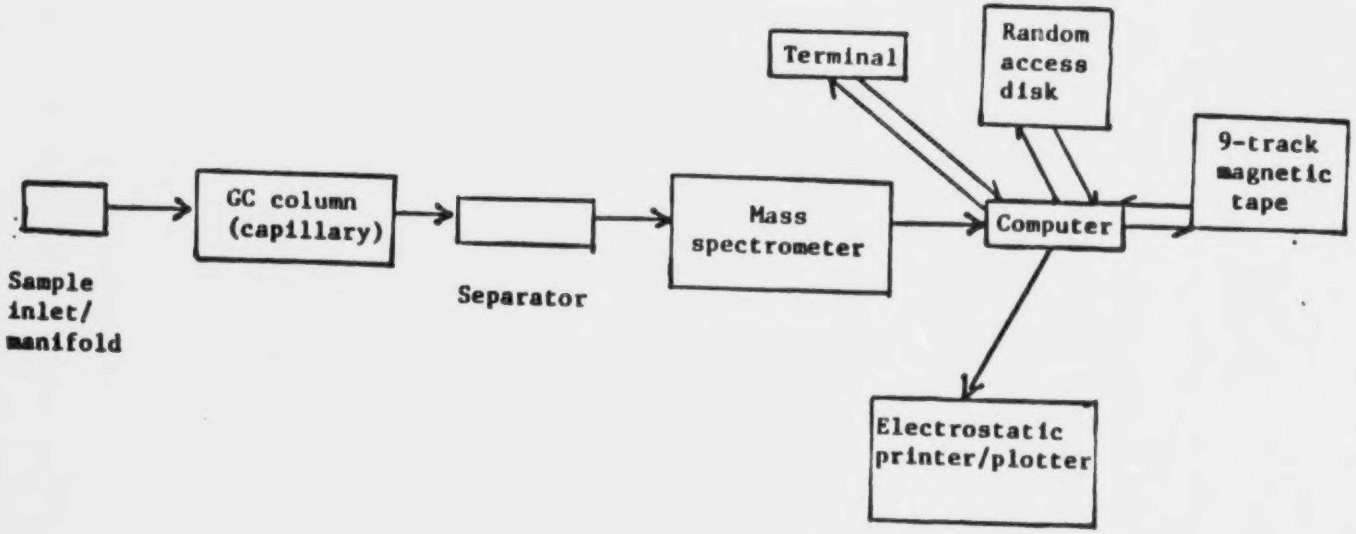

Sample
inlet/
manifold
GC column
(capillary)
Separator
Mass
spectrometer
Terminal
Random
access
disk
Computer
9-track
magnetic
tape
Electrostatic
printer/plotter

Figure B4. Schematic diagram of GC-MS computer system.

reset period requires approximately 2.0 seconds. Thus, a continuous scan cycle of 3.8 seconds/scan is maintained and repetitively executed throughout the chromatographic run. The result is the accumulation of a continuous series of mass spectra throughout the chromatographic run in sequential fashion.

Prior to analysis of unknown samples, the system is calibrated by introducing a standard substance, perfluorokerosene, into the instrument and determining the time of appearance of the known standard peaks in relation to the scanning magnetic field. The calibration curve thus generated is stored in the 620/L computer memory. This calibration serves only to calibrate the ions over the scanning range.

While the magnet is continuously scanning, the sample is injected and automatic data acquisition is initiated. As each spectrum is acquired by the computer, each peak which exceeds a preset threshold is recognized and reduced to centroid time and peak intensity. This information is stored in the computer core while the scan is in progress. In addition, approximately 30 total ion current values and an equal number of Hall probe signals are stored in the core of the computer as they are acquired. During the two-second period between scans this spectral information, along with the spectrum number, is written sequentially on magnetic tape, and the computer is reset for the acquisition of the next spectrum.

This procedure continues until the entire GC run is completed. By this time there are from 800-1400 spectra on the magnetic tape which are then subsequently processed. Depending on the information required, they may then either be processed immediately or additional samples may be run, stored on magnetic tape and the results examined at a later time.

The mass spectral data are processed in the following manner. First, the original spectra are scanned and the total ion current (TIC) information is extracted. Then the TIC intensities are plotted against the spectrum number on the Statos 31 recorder. The information will generally indicate whether the run is suitable for further processing, since it provides some idea of the number of unknowns in the sample and the resolution obtained using the particular GC column conditions.

The next stage of the processing involves the conversion of the spectral peak times to peak masses which is done directly via the dual disk system. The mass conversion is accomplished by use of the calibration table obtained previously using perfluorokerosene. Normally one set of the calibration data is sufficient for an entire day's data processing since the characteristics of the Hall probe are such that the variation in calibration is less than 0.2 daltons/day. A typical time required for this conversion process for 1,000 spectra is approximately 30 min.

After the spectra are obtained in mass converted form, processing proceeds either manually or by computer. In the manual mode, the full spectrum of scans for the GC run is recorded on the Statos 31 plotter. The TIC information available at this time is most useful for deciding the unknowns are produced at TUCC and printed out at the high speed terminals located on the RTI campus or TUCC.

8.3.2 Quantitative Analysis

In many cases the estimation of the level of pollutants by capillary gas chromatography in combination with mass spectrometry is not feasible utilizing only the total ion current monitor (See Figure B2, for example). Since baseline resolution between peaks is not always achieved, we employ the techniques which have previously been developed under contract whereby full spectra are obtained during the chromatographic separation step and the selected ions are presented as mass fragmentograms using computer software programs which allow the possibility of deconvoluting constituents which were not resolved in the total ion current chromatogram (5). Examples are depicted in Figures B5 and B6 which represent an ambient air sample with a TIC profile as in Figure B2.

In our GC/MS/COMP systems we request from the dedicated computer mass fragmentograms for any combination of ions when full mass spectra have been obtained during chromatography. Thus selectivity is obtained by choosing characteristic ions for a particular organic substance. The ion intensity is plotted and the ion intensity vs. time is subsequently used for quantification. Also quantification with external standards is easily achieved using the intensity of the total ion current monitor or a characteristic ion in the mass spectrum of the external standard. Thus, we use mass fragmentography for the quantification of organics in ambient air when the total ion current monitor is inadequate because of the lack of complete resolution between components in the mixture. which spectra are to be analyzed. At the beginning of the runs where peaks are very sharp nearly every spectrum must be inspected individually to determine the identity of the component. Later in the chromatographic run when the peaks are broader only selected scans need to be analyzed.

Identification of resolved components from data produced by the mass spectrometer system is achieved by comparing the fragmentation patterns of the unknown mass spectra to an eight major peak index of mass spectra (8). When feasible, the identification of unknowns is

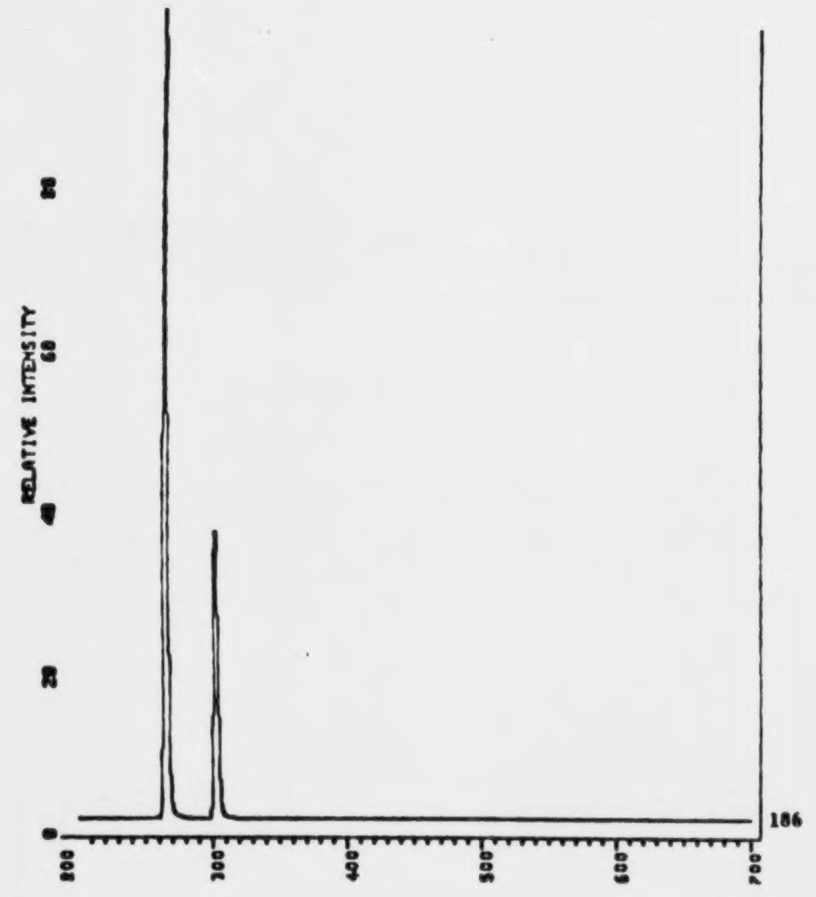


Figure B5. Mass fragmentogram of ions characteristic of internal standards (perfluorobenzene, m/z 186 and perfluorotoluene, m/z 236 with a fragment at m/z 186) used in ambient air samples.

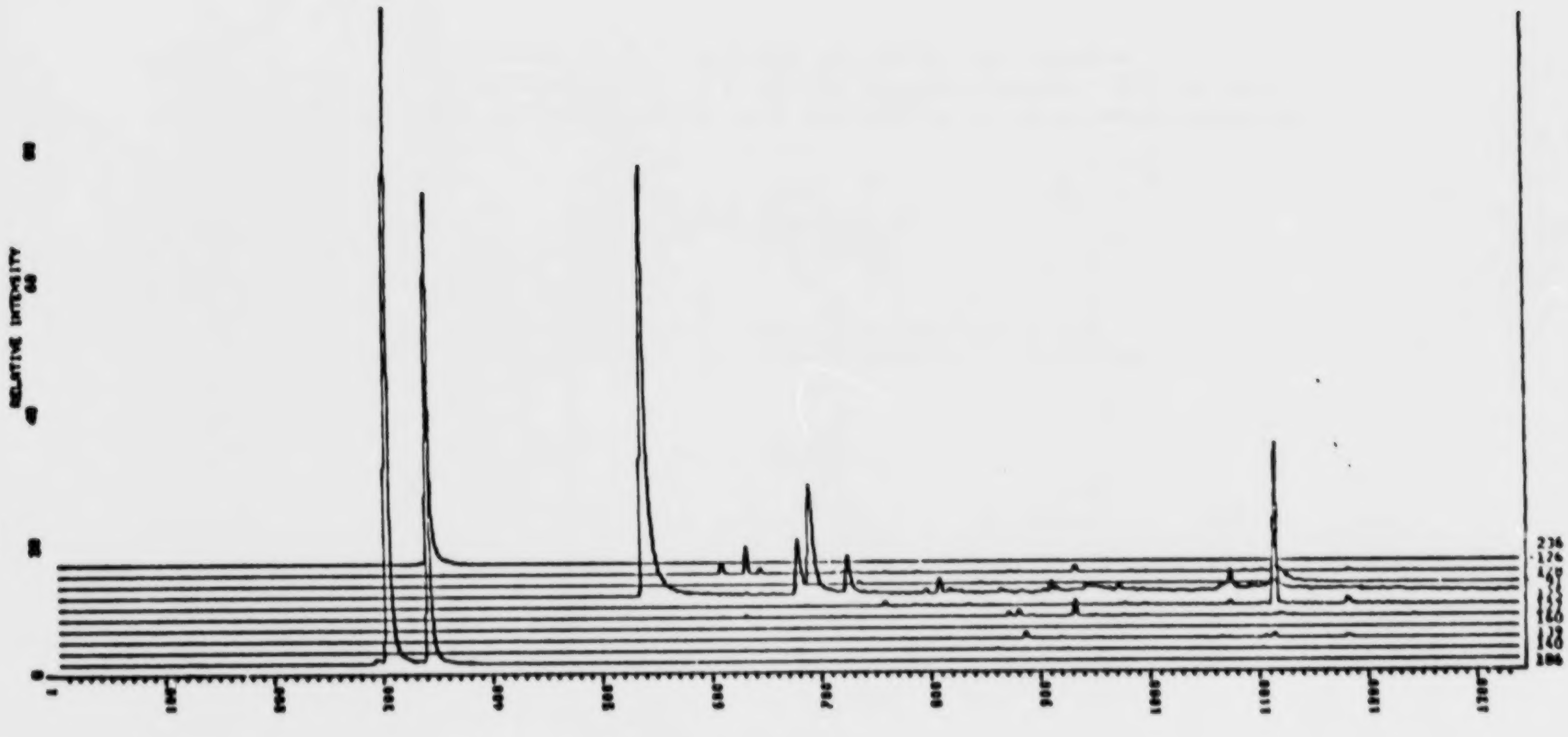


Figure B6. Mass fragmentograms of characteristic ions representing chlorotoluene (m/z 91,126,128), dichlorotoluene (m/z 125,127,160), chlorobenzaldehyde (m/z 139,140) and standards perfluorobenzene (m/z 186) and perfluorotoluene (m/z 236).

confirmed by comparing the fragmentation pattern and elution temperatures for two different chromatographic columns (SE-30 and Carbowax SCOT capillaries) for the unknown and authentic compounds. The relationship between the boiling point of the identified compound and the elution temperature on a non-polar column (the order of elution of constituents is predictable in homologous series since the SE-30 SCOT capillary separates primarily on the basis of boiling point) is carefully considered in making structure assignments.

Mass spectral search programs are operational at the Triangle Universities Computation Center (TUCC). RTI maintains twice daily service to TUCC, which is a one-quarter mile distance from the RTI campus. Additional information about each magnetic tape containing mass spectra is entered directly into the TUCC job stream using a remote job entry processing. This is normally done at TUCC using one of the five terminals located within the Analytical Sciences Laboratory. The control information contains selected spectrum numbers with instructions to process entire GC runs. The computer program systems simultaneously compare either the entire library of 25,000 compounds or some subset of this library. The complete reports showing the best fits for each of

As described previously, the quantitation of constituents in ambient air samples is accomplished either by utilizing the total ion current monitor or, where necessary, mass fragmentograms. In order to eliminate the need to obtain complete calibration curves for each compound for which quantitative information is desired, we use the method of relative molar response (RMR) factors (9). Successful use of this method requires information on the exact amount of standard added and the relationship of RMR (unknown) to the RMR (standards). The method of calculations is as follows:

$$(1)\quad \mathrm{RMR}_{\mathrm{unknown/standard}} = \frac{A_{\mathrm{unk}}/\mathrm{Moles}_{\mathrm{unk}}}{A_{\mathrm{std}}/\mathrm{Moles}_{\mathrm{std}}}$$

A = system response, height or area determined by integration or triangulation.

The value of RMR is determined from at least three independent analyses.

$$(2)\quad \mathrm{RMR}_{\mathrm{unk/std}} = \frac{A_{\mathrm{unk}}/g_{\mathrm{unk}}/\mathrm{GMW}_{\mathrm{unk}}}{A_{\mathrm{std}}/g_{\mathrm{std}}/\mathrm{GMW}_{\mathrm{std}}}$$

A = system response, as above
g = number of grams present
GMW = gram molecular weight

$$(3)\quad g_{\mathrm{unk}} = \frac{A_{\mathrm{unk}}\cdot \mathrm{GMW}_{\mathrm{unk}}\cdot g_{\mathrm{std}}}{A_{\mathrm{std}}\cdot \mathrm{GMW}_{\mathrm{std}}\cdot \mathrm{RMR}_{\mathrm{unk/std}}}$$

The standard can be added as an internal standard during sampling. Since, however, the volume of air taken to produce a given sample is accurately known, it is also possible and more practical to use an external standard where the standard is introduced into the cartridge prior to its analysis. Two standards, hexafluorobenzene and octafluorotoluene, are used for the purpose of calculating RMR's. From previous research it has been determined that the retention times for these two compounds are such that they elute from the glass capillary column (SE-30) at a temperature and retention time which does not interfere with the analysis of unknown compounds in ambient air samples.

Since the volume of air taken to produce a given sample is accurately known and an external standard is added to the sample, then the weight per cartridge and hence the concentration of the unknown can be determined. The approach for quantitating ambient air pollutants requires that the RMR be determined for each constituent of interest. This means that when an ambient air sample is taken, the external standard is added at a known concentration during the analysis. It is not imperative at this point to know what the RMR of each of the constituents in the sample happens to be. However, after the unknowns are identified then the RMR can subsequently be determined and the unknown concentration calculated in the original sample using the RMR. In this manner it is possible to obtain qualitative and quantitative information on the same sample with a minimum of effort.

9.0 References

1. Pellizzari, E. D., Development of Method for Carcinogenic Vapor Analysis in Ambient Atmospheres. Publication No. EPA-650/2-74-121, Contract No. 68-02-1228, 148 pp., July, 1974.
2. Pellizzari, E. D., Development of Analytical Techniques for Measuring Ambient Atmospheric Carcinogenic Vapors. Publication No. EPA-600/2-75-075, Contract No. 68-02-1228, 187 pp., November, 1975.
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5. Pellizzari, E. D., J. E. Bunch, R. E. Berkley and J. McRae, Anal. Chem., 48, 803 (1976).
6. Pellizzari, E. D., Quarterly Report No. 1, EPA Contract No. 68-02-2262, February, 1976.
7. Pellizzari, E. D., J. E. Bunch, R. E. Berkley and J. McRae, Anal. Lett., 9, 45 (1976).
8. "Eight Peak Index of Mass Spectra", Vol. I, (Tables 1 and 2) and II (Table 3), Mass Spectrometry Data Centre, AWRE, Aldermaston, Reading, RF74PR, UF, 1970.
9. Pellizzari, E. D., Quarterly Report No. 3, EPA Contract No. 68-02-2262, in preparation.

Written analytical protocol prepared 1/24/77.

APPENDIX C

ANALYTICAL PROCEDURES FOR DICHOTOMOUS FILTERS

1.0 Houston Aerosol Study - Dichotomous Filter Analysis Protocol

1.1 Extraction

Using the custom made Teflon extraction block provided by the EPA (Inorganic Pollutant Analysis Branch), each filter was extracted with ∿ 4 mL of $CHCl_3$ (all glass distilled - Burdick & Jackson) by sonication (water bath) for 5 min. The contents of the extraction block are added and removed via a 5 mL glass syringe fitted (Luer) with a stainless steel needle. The contents are transferred in ∿ 2 mL aliquots to sedimentation tubes (Bauer-Schenck) for solvent removal.

The tubes are placed under a gentle stream of N_2 for removal of solvent (no external heating of the sedimentation tubes is provided). After all solvent has been evaporated, the sides of the tubes are carefully washed 3 times with 100, 50 and then 20 μL aliquots of fresh solvent in order to concentrate the dissolved organics in the lower portion of the tube. After these washes, the samples are taken to dryness, and stored, covered, under refrigeration until just prior to GC/MS analysis. At that point the tube is allowed to come to room temperature and 10.0 μL of $CHCl_3$ (B-J) is added directly to the bottom portion of the tube. The tube is placed briefly (∿ 2 sec) in a sonic bath to aid in dissolution of sample components.

1.2 GC/MS Analysis

Analysis is carried out by injection of ∿ 1 μL aliquots into an LKB 2091 gas chromatograph/mass spectrometer. The spectrometer is operated under computer control. The start time and scan interval time are selected by the operator. Typically the magnet is scanned from m/z 5 to m/z 490 at a scan speed of 2 secs full scan 0 → 670 daltons. The scan cycle time is typically 2.4 secs. Mass *vs*. intensity data is acquired by the computer and is stored on a disk. The mass values are determined by the LKB mass marker and modified as necessary by a computer program which corrects for deviations due to scan speed. The mass calibration tables are stable for over a six month period of time. The data can then be plotted as total ion current (over an operator determined mass range-usually m/z 33 → m/z 492) versus spectrum number.

This information is useful in deciding which spectra should be plotted and interpreted. Normally all spectra from the air peak on are plotted. Data are stored archivally on 9-track IBM compatible magnetic tapes. The data so obtained are treated as described in Appendix [illegible], Section 8.3.2

APPENDIX D

ANALYTICAL PROCEDURES FOR HI-VOL QUARTZ FIBER FILTERS

1.0 Houston Aerosol Study - Hi-Vol Filter Analysis Protocol

All work is to be carried out under yellow lights to minimize photodecomposition of sample components. Except for the use of aqueous acid and base, all glassware is to be silanized prior to use. It is imperative that sample materials be only exposed to glass, Teflon or stainless steel surfaces during extraction, partition and analysis. Stopcock grease, plastic or rubber tubing or fittings and non-glass container caps must be avoided not only for sample solutions, but also for the storage of solutions (e.g., aqueous base or acid) that might come into contact with the sample.

1.1 Extraction

Each Hi-Vol filter is to be cut, using clean stainless steel scissors, into approximately one cm^2 squares. The squares are placed in a clean ceramic Soxhlet thimble. The thimble contents are then Soxhlet extracted using methanol (Burdick & Jackson) for four hours. The methanol solution is then concentrated, by rotary evaporation (less than or equal to 50°C) to approximately 20 mL. The solution is then quantitatively transferred to a centrifuge tube and spun to remove inorganics. The supernatant is transferred to a 5L ml round bottom flask and the centrifuge tube contents are washed two times with 1 mL each of methanol and the combined washings transferred to the round bottom flask. The combined solutions are rotary evaporated to dryness and the contents quantitatively transferred to a tared vial (2 dr) with 1% methanol in methylene chloride (Burdick & Jackson). The contents of the vial are taken to dryness with a nitrogen stream. The last traces of solvent are removed by brief vacuum treatment (approximately 2 minutes), the vial is reweighed and the weight of the organic extractables is noted. The contents are removed from the vial with methylene chloride (sonicate) and transferred to a separatory funnel for partition.

1.2 Partition

The partition sequence to be followed is as discussed in Section 5.3. Each fraction should be concentrated in a tared vial and the weight noted. Only Burdick & Jackson solvents are to be used. Depending on final weights, various sized conical vials should be used for preparation of samples for analysis by GC/MS.

1.3 GC/MS Analysis

Analyses of portions of the fractions obtained from the partition scheme will be carried out with an LKB 2091 gas chromatograph/mass spectrometer. The GC/MS procedure is described in Appendix D (Section 8.3.2) and Appendix E (Section 1.2).

APPENDIX E

VAPOR-PHASE ORGANICS IDENTIFIED FROM IITRI COLLECTION SYSTEM

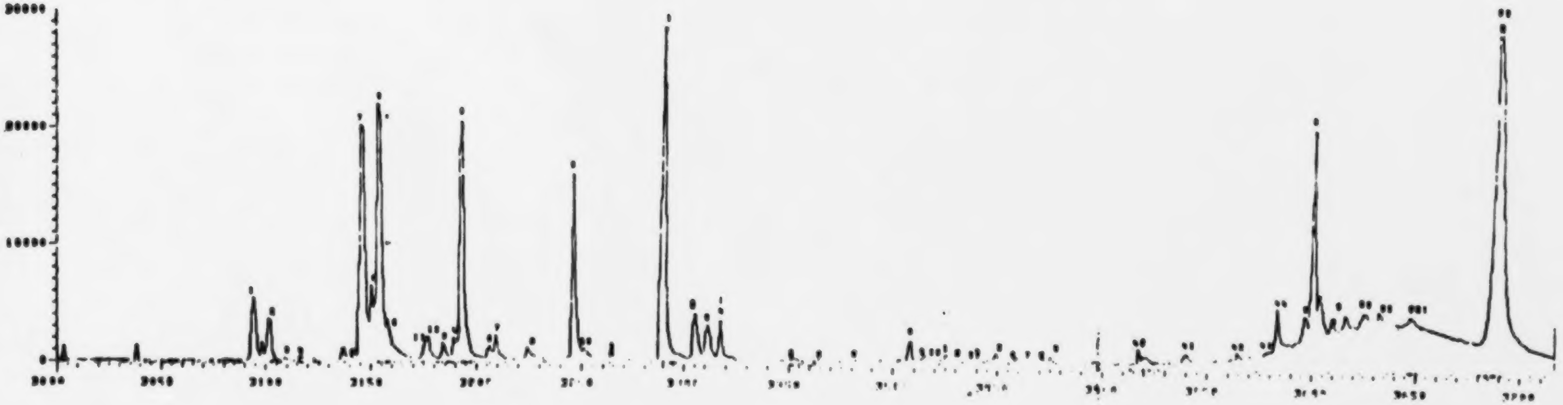

Figure E1. Total ion current plot, IITRI sampler #1, cartridge pair #1, upstream cartridge (blank).

TABLE E1. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #1, IITRI SAMPLER #1 (BLANK)

13000-13796

Chromatographic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound
1	0.46	52	CO_2
3A	0.56	59	C_4H_8 isomer
4	0.57	60	acetaldehyde
5	0.67	67	isopentane
7	0.70	69	acetone
7A	0.70	69	*n*-pentane
8	0.73	71	diethyl ether (tent.)
9	0.74	72	methylene chloride
10A	0.79	75	C_6H_{14} isomer
11	0.84	79	cyclopentane
12	0.86	80	2-methylpentane
13	0.90	83	3-methylpentane
13A	0.91	84	*n*-butanal
14	0.93	85	hexafluorobenzene (eF)
15	0.94	86	*n*-hexane
15A	0.96	87	chloroform
16	1.00	90	perfluorotoluene (eF)
17	1.01	91	methylcyclopentane
17A	1.03	92	1,2-dichloroethane
17B	1.04	93	1,1,1-trichloroethane (traces)
18	1.10	97	benzene
18A	1.11	98	carbon tetrachloride
18B	1.13	99	cyclohexane
19	1.20	104	trichloroethylene
20	1.23	106	*n*-heptane
21	1.41	119	toluene
22	1.49	124	C_8H_{16} isomer
23	1.51	126	C_8H_{16} isomer
24	1.54	128	C_8H_{16} isomer + tetrachloroethylene
24A	1.69	138	ethylbenzene
25	1.71	140	xylene isomer
25A	1.76	143	sat. hydrocarbon
25B	1.77	144	styrene (traces)
25C	1.79	145	*o*-xylene
25D	1.80	146	*n*-heptanal (tent.)
26	1.81	147	*n*-nonane
26A	1.86	150	sat. hydrocarbon
26B	1.90	153	sat. hydrocarbon
27	1.91	154	$C_{10}H_{16}$ isomer
27A	1.97	158	benzaldehyde + C_3-alkyl benzene isomer
28	1.99	159	$C_{11}H_{24}$ isomer
28A	2.01	161	C_3H_5-benzene isomer
29	2.02	162	$C_{11}H_{24}$ isomer
30	2.06	164	C_3-alkyl benzene isomer
31	2.07	165	*n*-decane
32	2.09	166	dichlorobenzene isomer
33	2.13	169	sat. hydrocarbon
34	2.14	170	sat. hydrocarbon
34A	2.16	171	$C_{10}H_{16}$ isomer
35	2.19	173	sat. hydrocarbon
35A	2.21	175	C_4-alkyl benzene isomer
36	2.24	177	acetophenone + sat. hydrocarbon isomer
36A	2.27	179	C_4-alkyl benzene isomer
37	2.29	180	sat. hydrocarbon (tent.)
38	2.30	181	*n*-nonanal
38A	2.30	181	$C_{11}H_{22}$ isomer
39	2.31	182	*n*-undecane
39A	2.36	185	C_4-alkyl benzene isomer
39B	2.37	186	C_4-alkyl benzene isomer
39C	2.40	188	C_4-alkyl benzene + C_4H_7-benzene isomers (traces)
39D	2.47	193	sat. hydrocarbon
39E	2.51	196	naphthalene
40	2.53	197	*n*-dodecane
40A	2.53	197	C_5-alkyl benzene isomer (traces)
41	2.63	204	chloroprene dimer
41A	2.67	207	unsat. hydrocarbon
42	2.74	212	*n*-tridecane
42A	2.77	214	β-methylnaphthalene
42B	2.79	215	unsat. hydrocarbon
42C	2.80	216	$C_{14}H_{26}$ isomer
43	2.81	217	unsat. hydrocarbon
44	2.84	219	fluor-chloro compound unknown M.W.> 300
44A	2.89	222	unsat. hydrocarbon
45	2.90	223	fluor-chloro compound unknown M.W. >300
46	2.93	225	fluor compound unknown M.W. > 300

TABLE E1. (CONT'D)

Chromato- graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound	Chromato- graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound
47	2.94	226	fluor compound unknown M.W. > 300				
48	2.97	228	$C_{15}H_{28}$ isomer				
49	3.00	230	unsat. hydrocarbon				
50	3.06	234	unsat. hydrocarbon				
51	3.09	236	unsat. hydrocarbon				
52	3.14	240	unsat. hydrocarbon				

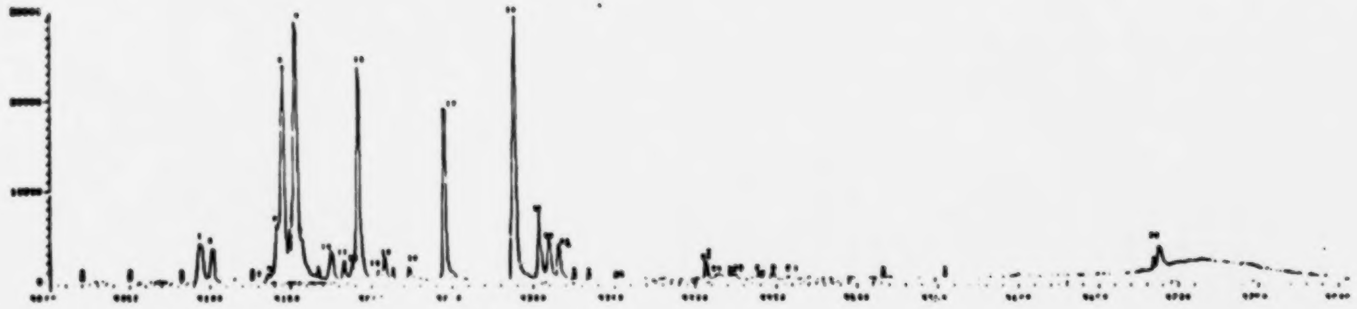

Figure E2. Total ion current plot, IITRI sampler #1, cartridge pair #1, downstream cartridge (blank).

TABLE E2. COMPOUNDS IDENTIFIED IN DOWNSTREAM CARTRIDGE, CARTRIDGE PAIR #1, IITRI SAMPLER #1 (BLANK)

Chromato-graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound
1	0.46	52	CO_2
2B	0.56	59	C_4H_8 isomer
2C	0.56	59	C_4H_{10} isomer
2D	0.57	60	acetaldehyde
4	0.67	67	isopentane
5	0.69	68	acetone
6	0.70	69	*n*-pentane
7	0.73	71	diethyl ether
8	0.74	72	methylene chloride
9A	0.84	79	C_5H_{10} isomer
10	0.86	80	2-methylpentane
11	0.89	82	3-methylpentane
11A	0.90	83	*n*-butanal
12	0.91	84	hexafluorbenzene (eI)
13	0.94	86	*n*-hexane
13A	0.96	87	chloroform
14	1.00	90	perfluorotoluene (eI)
15	1.01	91	methylcyclopentane
15A	1.03	92	1,2-dichloroethane
16	1.09	96	benzene
16A	1.10	97	carbon tetrachloride
16B	1.11	98	cyclohexane
17	1.19	103	trichloroethylene
17A	1.21	105	*n*-heptane
18	1.40	118	toluene
18A	1.43	120	C_8H_{18} isomer
19	1.47	123	C_8H_{16} isomer
20	1.50	125	C_8H_{16} isomer
21	1.54	128	C_8H_{16} isomer + tetrachloroethylene (traces)
21A	1.67	137	ethylbenzene
22	1.70	139	xylene isomer
22A	1.76	143	styrene
22B	1.77	144	*o*-xylene
22C	1.79	145	C_9H_{18} isomer
22D	1.80	146	C_9H_{20} isomer
22E	1.84	149	$C_{10}H_{22}$ isomer
22F	1.89	152	$C_{10}H_{20}$ isomer
22G	1.96	157	C_3-alkyl benzene isomer
22H	1.96	157	benzaldehyde
23	1.97	158	$C_{11}H_{24}$ isomer
24	2.01	161	sat. hydrocarbon
24A	2.04	163	C_3-alkyl benzene
25	2.07	165	$C_{11}H_{24}$ isomer
25A	2.11	168	sat. hydrocarbon
26	2.14	170	sat. hydrocarbon
27	2.16	171	sat. hydrocarbon
28	2.17	172	$C_{11}H_{24}$
29	2.23	176	sat. hydrocarbon

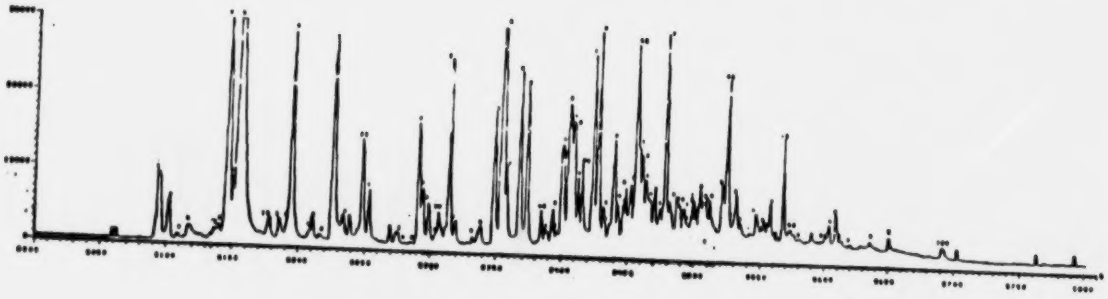

Figure E3. Total ion current plot, IITRI sampler #1, cartridge pair #2, upstream cartridge.

TABLE E3. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #2, IITRI SAMPLER #1

15000-15787

Chromato-graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound
1	0.44	51	CO_2
3A	0.54	58	C_4H_8 isomer
3B	0.56	59	C_4H_{10} isomer
4	0.56	59	acetaldehyde
5	0.66	66	isopentane
6A	0.67	67	propenal
6B	0.69	68	furan
6C	0.69	68	acetone
7	0.70	69	*n*-pentane
8	0.71	70	diethyl ether (tent.)
9	0.73	71	methylene chloride
9A	0.83	78	cyclopentane
10	0.84	79	2-methylpentane
11	0.89	82	3-methylpentane
11A	0.90	83	*n*-butanal
12	0.91	84	hexafluorobenzene (eF)
13	0.93	85	*n*-hexane
13A	0.94	86	chloroform
13B	0.96	87	2-butanone
13C	0.97	88	ethyl acetate (tent.)
14	1.00	90	perfluorotoluene (eF)
15	1.01	91	methylcyclopentane
15A	1.03	92	1,2-dichloroethane
15B	1.04	93	1,1,1-trichloroethane
16	1.04	93	tetrahydrofuran
16A	1.09	96	C_6H_{10} isomer
17	1.09	96	benzene
17A	1.10	97	carbon tetrachloride
17B	1.11	98	cyclohexane
18	1.13	99	2-methylhexane
18A	1.14	1.00	2,3-dimethylpentane
19	1.16	101	3-methylhexane
19A	1.19	103	$C_5H_{10}O$ + C_7H_{14} isomers
20	1.20	104	trichloroethylene
21	1.23	106	*n*-heptane
21A	1.24	107	2,4-dimethylfuran
21B	1.27	109	C_7H_{14} isomer (tent.)
22	1.30	111	methylcyclohexane
22A	1.31	112	C_8H_{18} isomer
23	1.33	113	4-methyl-2-pentanone
24	1.36	115	C_8H_{16} isomer
24A	1.37	116	C_8H_{16} isomer
25	1.39	117	C_8H_{18} isomer
25A	1.40	118	C_8H_{16} isomer
26	1.41	119	toluene
27	1.43	120	C_8H_{18} isomer
28	1.44	121	C_8H_{18} isomer
29	1.47	123	2-hexanone + C_8H_{16} isomer
30	1.49	124	C_8H_{16} isomer
30A	1.50	125	C_8H_{14} isomer
30B	1.51	126	C_8H_{16} isomer
31	1.53	127	*n*-octane
32	1.56	129	C_8H_{16} isomer
32A	1.56	129	tetrachloroethylene
32B	1.60	132	C_9H_{20} isomer
33	1.61	133	C_9H_{20} isomer
33A	1.63	134	C_8H_{16} isomer
33B	1.64	135	C_9H_{20} isomer
34	1.64	135	chlorobenzene
34A	1.67	137	C_9H_{18} isomer
34B	1.69	138	C_9H_{18} isomer
35	1.70	139	ethylbenzene
36	1.71	140	xylene + C_9H_{20} isomer
37	1.74	142	C_9H_{20} isomer
37A	1.76	143	2-heptanone
37B	1.77	144	styrene
38	1.79	145	*O*-xylene
38A	1.80	146	C_9H_{18} isomer
39	1.81	147	*n*-nonane
39A	1.84	149	C_9H_{18} isomer
39B	1.86	150	$C_{10}H_{22}$ isomer
40	1.87	151	isopropylbenzene
41	1.89	152	$C_{10}H_{22}$ isomer
41A	1.90	153	$C_{10}H_{22}$ isomer
42	1.91	154	propylcyclohexane
42A	1.91	154	$C_{10}H_{20}$ isomer
43	1.93	155	$C_{10}H_{22}$ isomer
44	1.94	156	benzaldehyde
45	1.94	156	*n*-propylbenzene
46	1.97	158	ethyltoluene isomer
47	1.97	158	$C_{10}H_{22}$ isomer
48	1.99	159	1,3,5-trimethylbenzene
48A	1.99	159	$C_{11}H_{24}$ isomer
49	2.00	160	$C_{10}H_{22}$ isomer

TABLE E3 (CONT'D)

Chromato-graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound
50	2.01	161	o-ethyltoluene
50A	2.03	162	$C_{11}H_{24}$ isomer
50B	2.03	162	$C_{10}H_{20}$ isomer + phenol
50C	2.03	162	$C_{10}H_{18}$ isomer
50D	2.04	163	$C_{10}H_{20}$ isomer
51	2.06	164	1,2,4-trimethylbenzene
51A	2.06	164	$C_{10}H_{20}$ isomer
52	2.07	165	n-decane
52A	2.09	166	$C_{10}H_{20}$ isomer
53	2.09	166	dichlorobenzene isomer
53A	2.10	167	C_4-alkyl benzene isomer
54	2.11	168	C_4-alkyl benzene + $C_{11}H_{24}$ isomers
55	2.13	169	1,2,3-trimethylbenzene + $C_{11}H_{24}$ isomer
56	2.14	170	$C_{11}H_{24}$ isomer
57	2.16	171	indan
58	2.17	172	butylcyclohexane
58A	2.19	173	$C_{11}H_{22}$ + C_4-alkyl benzene isomers
59	2.19	173	C_4-alkyl benzene isomer
59A	2.20	174	C_4-alkyl benzene isomer
60	2.21	175	acetophenone
61	2.23	176	$C_{11}H_{24}$ isomer
62	2.24	177	C_4-alkyl benzene isomer
62A	2.24	177	$C_{11}H_{24}$ isomer
63	2.26	178	n-nonanal + $C_{11}H_{20}$ isomer
63A	2.26	178	C_4-alkyl benzene isomer
64	2.27	179	C_4-alkyl benzene isomer
64A	2.27	179	$C_{11}H_{22}$ isomer
65	2.29	180	C_4-alkyl benzene isomer
65A	2.30	181	C_4H_7-benzene isomer
66	2.30	181	$C_{11}H_{22}$ isomer
67	2.31	182	n-undecane
67A	2.33	183	C_5-alkyl benzene isomer
68	2.34	184	$C_{11}H_{22}$ + C_4-alkyl benzene isomers
69	2.36	185	C_4-alkyl benzene + $C_{12}H_{26}$ isomers
70	2.37	186	C_4-alkyl benzene isomer
71	2.39	187	$C_{12}H_{26}$ isomer
71A	2.39	187	$C_{11}H_{20}$ isomer
72	2.40	188	C_5-alkyl benzene isomer
72A	2.40	188	$C_{12}H_{24}$ isomer
72B	2.41	189	C_5-alkyl benzene isomer
73	2.43	190	C_5-alkyl cyclohexane isomer
73A	2.43	190	$C_{12}H_{24}$ isomer
74	2.44	191	C_5-alkyl benzene + $C_{11}H_{20}$ isomers
75	2.46	192	$C_{12}H_{26}$ isomer
75A	2.46	192	C_4-alkyl benzene isomer
76	2.46	192	C_5-alkyl benzene isomer
76A	2.47	1.93	$C_{12}H_{24}$ isomer
76B	2.47	193	$C_{12}H_{26}$ isomer
77	2.47	193	C_5-alkyl benzene isomer
77A	2.49	194	$C_{12}H_{24}$ isomer
78	2.49	194	$C_{12}H_{26}$ isomer
78A	2.49	194	C_5-alkyl benzene isomer
78B	2.51	196	$C_{13}H_{26}$ isomer
78C	2.53	197	$C_{13}H_{24}$ isomer
79	2.53	197	naphthalene
79A	2.54	198	$C_{12}H_{24}$ isomer
80	2.54	198	n-dodecane
80A	2.56	199	$C_{12}H_{22}$ isomer
81	2.57	200	$C_{12}H_{24}$ isomer
82	2.59	201	$C_{13}H_{28}$ isomer
83	2.60	202	$C_{13}H_{28}$ + C_6-alkyl benzene isomers
83A	2.64	205	$C_{13}H_{26}$ isomer
84	2.66	206	C_6-alkyl cyclohexane isomer
84A	2.67	207	$C_{13}H_{26}$ isomer
85	2.69	208	$C_{13}H_{28}$ isomer
85A	2.70	209	$C_{13}H_{26}$ isomer
86	2.70	209	$C_{13}H_{28}$ isomer
87	2.71	210	$C_{14}H_{30}$ isomer
88	2.74	212	$C_{13}H_{24}$ isomer
89	2.76	213	n-tridecane
90	2.79	215	β-methylnaphthalene
90A	2.79	215	$C_{13}H_{26}$ isomer
91	2.80	216	$C_{14}H_{28}$ isomer
91A	2.81	217	α-methylnaphthalene
92	2.87	221	C_7-alkyl cyclohexane isomer

TABLE E3 (CONT'D)

Chromato-graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound
50	2.01	161	*o*-ethyltoluene
50A	2.03	162	$C_{11}H_{24}$ isomer
50B	2.03	162	$C_{10}H_{20}$ isomer + phenol
50C	2.03	162	$C_{10}H_{18}$ isomer
50D	2.04	163	$C_{10}H_{20}$ isomer
51	2.06	164	1,2,4-trimethylbenzene
51A	2.06	164	$C_{10}H_{20}$ isomer
52	2.07	165	*n*-decane
52A	2.09	166	$C_{10}H_{20}$ isomer
53	2.09	166	dichlorobenzene isomer
53A	2.10	167	C_4-alkyl benzene isomer
54	2.11	168	C_4-alkyl benzene + $C_{11}H_{24}$ isomers
55	2.13	169	1,2,3-trimethylbenzene + $C_{11}H_{24}$ isomer
56	2.14	170	$C_{11}H_{24}$ isomer
57	2.16	171	indan
58	2.17	172	butylcyclohexane
58A	2.19	173	$C_{11}H_{22}$ + C_4-alkyl benzene isomers
59	2.19	173	C_4-alkyl benzene isomer
59A	2.20	174	C_4-alkyl benzene isomer
60	2.21	175	acetophenone
61	2.23	176	$C_{11}H_{24}$ isomer
62	2.24	177	C_4-alkyl benzene isomer
62A	2.24	177	$C_{11}H_{24}$ isomer
63	2.26	178	*n*-nonanal + $C_{11}H_{20}$ isomer
63A	2.26	178	C_4-alkyl benzene isomer
64	2.27	179	C_4-alkyl benzene isomer
64A	2.27	179	$C_{11}H_{22}$ isomer .
65	2.29	180	C_4-alkyl benzene isomer
65A	2.30	181	C_4H_7-benzene isomer
66	2.30	181	$C_{11}H_{22}$ isomer
67	2.31	182	*n*-undecane
67A	2.33	183	C_5-alkyl benzene isomer
68	2.34	184	$C_{11}H_{22}$ + C_4-alkyl benzene isomers
69	2.36	185	C_4-alkyl benzene + $C_{12}H_{26}$ isomers
70	2.37	186	C_4-alkyl benzene isomer
71	2.39	187	$C_{12}H_{26}$ isomer
71A	2.39	187	$C_{11}H_{20}$ isomer
72	2.40	188	C_5-alkyl benzene isomer
72A	2.40	188	$C_{12}H_{24}$ isomer
72B	2.41	189	C_5-alkyl benzene isomer
73	2.43	190	C_5-alkyl cyclohexane isomer
73A	2.43	190	$C_{12}H_{24}$ isomer
74	2.44	191	C_5-alkyl benzene + $C_{11}H_{20}$ isomers
75	2.46	192	$C_{12}H_{26}$ isomer
75A	2.46	192	C_4-alkyl benzene isomer
76	2.46	192	C_5-alkyl benzene isomer
76A	2.47	1.93	$C_{12}H_{24}$ isomer
76B	2.47	193	$C_{12}H_{26}$ isomer
77	2.47	193	C_5-alkyl benzene isomer
77A	2.49	194	$C_{12}H_{24}$ isomer
78	2.49	194	$C_{12}H_{26}$ isomer
78A	2.49	194	C_5-alkyl benzene isomer
78B	2.51	196	$C_{13}H_{26}$ isomer
78C	2.53	197	$C_{13}H_{24}$ isomer
79	2.53	197	naphthalene
79A	2.54	198	$C_{12}H_{24}$ isomer
80	2.54	198	*n*-dodecane
80A	2.56	199	$C_{12}H_{22}$ isomer
81	2.57	200	$C_{12}H_{24}$ isomer
82	2.59	201	$C_{13}H_{28}$ isomer
83	2.60	202	$C_{13}H_{28}$ + C_6-alkyl benzene isomers
83A	2.64	205	$C_{13}H_{26}$ isomer
84	2.66	206	C_6-alkyl cyclohexane isomer
84A	2.67	207	$C_{13}H_{26}$ isomer
85	2.69	208	$C_{13}H_{28}$ isomer
85A	2.70	209	$C_{13}H_{26}$ isomer
86	2.70	209	$C_{13}H_{28}$ isomer
87	2.71	210	$C_{14}H_{30}$ isomer
88	2.74	212	$C_{13}H_{24}$ isomer
89	2.76	213	*n*-tridecane
90	2.79	215	β-methylnaphthalene
90A	2.79	215	$C_{13}H_{26}$ isomer
91	2.80	216	$C_{14}H_{28}$ isomer
91A	2.81	217	α-methylnaphthalene
92	2.87	221	C_7-alkyl cyclohexane isomer

TABLE E3 (CONT'D)

Chromato-graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound	Chromato-graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound
92A	2.89	222	$C_{14}H_{28}$ isomer				
92B	2.90	223	$C_{14}H_{30}$ isomer				
93	2.93	225	$C_{15}H_{32}$ isomer				
94	2.94	226	fluor compound unknown				
95	2.96	227	*n*-tetradecane				
96	2.99	229	$C_{15}H_{28}$ isomer (tent.)				
97	3.01	231	unsat. hydrocarbon				
97A	3.07	235	$C_{15}H_{30}$ isomer				
98	3.10	237	unsat. hydrocarbon				
98A	3.13	239	$C_{15}H_{30}$ isomer				
99	3.15	240	unsat. hydrocarbon				

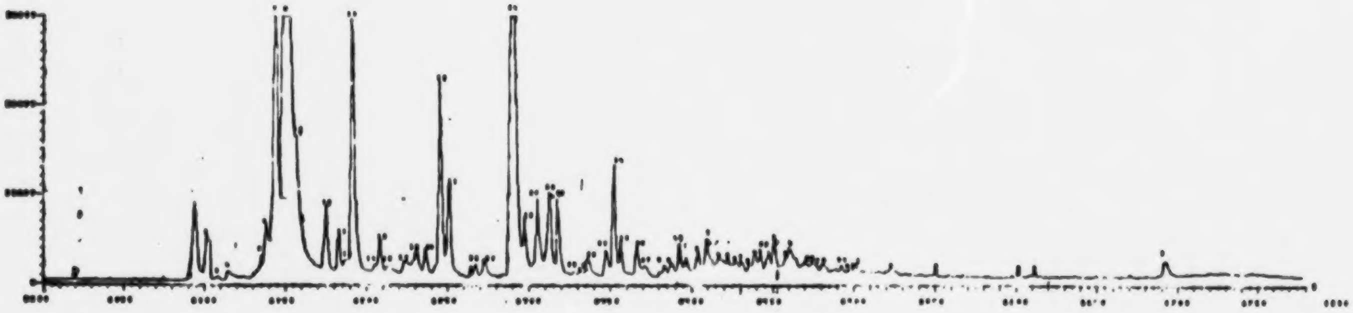

Figure E4. Total ion current plot, IITRI sampler #1, cartridge pair #2, downstream cartridge.

TABLE E4. COMPOUNDS IDENTIFIED IN DOWNSTREAM CARTRIDGE, CARTRIDGE PAIR #2, IITRI SAMPLER #1

Chromato-graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound
1	0.46	52	CO_2
3A	0.54	58	C_3H_8 isomer
4	0.57	59	n-butane
4A	0.57	60	acetaldehyde
5	0.66	66	isopentane
6A	0.69	68	acetone
7	0.70	69	n-pentane
8	0.75	71	methylene chloride
9A	0.77	74	C_6H_{14} isomer
9B	0.84	79	cyclopentane
10	0.86	80	2-methylpentane
11	0.89	82	3-methylpentane
11A	0.90	83	C_4H_8O isomer (tent.)
13	0.91	84	hexafluorobenzene (eS)
13A	0.94	86	chloroform
13B	0.97	88	ethyl acetate
14	1.00	90	perfluorotoluene (eS)
15	1.01	91	methylcyclopentane
15A	1.03	92	1,2-dichloroethane
16	1.04	93	tetrahydrofuran + 1,1,1-trichloroethane
17	1.10	97	benzene
17A	1.10	97	carbon tetrachloride
17B	1.11	98	cyclohexane
18	1.13	99	2-methylhexane
18A	1.14	100	2,5-dimethylpentane
19	1.16	101	3-methylhexane
19A	1.19	103	C_7H_{14} isomer
20	1.20	104	trichloroethylene
21	1.21	105	n-heptane
22	1.30	111	methylcyclohexane
22A	1.31	112	C_8H_{18} isomer
23	1.33	113	4-methyl-2-pentanone
23A	1.36	115	C_8H_{16} isomer
24	1.41	119	toluene
24A	1.43	120	C_8H_{18} isomer
25	1.44	121	2,4-dimethylhexane
24A	1.47	123	C_8H_{16} isomer
25	1.44	121	2,4-dimethylhexane
25A	1.47	123	C_8H_{16} isomer
25B	1.47	123	$C_5H_{10}O$ isomer
26	1.49	124	2-ethyl-1-hexane
26A	1.50	125	1,2-dibromoethane (traces) (tent.)
27	1.51	126	1-methyl-3-ethylcyclopentane or C_8H_{16} isomer
28	1.53	127	n-octane
28A	1.53	127	C_8H_{16} isomer
29	1.54	128	octene isomer + tetrachloroethylene
30	1.60	132	C_9H_{20} isomer
31	1.61	133	C_9H_{20} isomer
31A	1.63	134	C_8H_{16} isomer
31B	1.63	134	C_9H_{20} isomer
32	1.64	135	ethylcyclohexane
32A	1.64	135	chlorobenzene
32B	1.66	136	C_9H_{18} isomer
32C	1.69	138	C_9H_{18} isomer
33	1.70	139	ethylbenzene
33A	1.71	140	C_9H_{20} isomer
34	1.71	140	xylene isomer
35	1.73	141	C_9H_{20} isomer
35A	1.74	142	C_9H_{20} isomer
35B	1.76	143	C_9H_{18} isomer
35C	1.77	144	styrene
36	1.79	145	o-xylene
36A	1.80	146	C_9H_{12} isomer
37	1.81	147	C_9H_{20} isomer
37A	1.83	148	$C_7H_{14}O$ isomer
37B	1.86	150	C_9H_{18} isomer
38	1.87	151	$C_{10}H_{22}$ isomer
38A	1.87	151	isopropylbenzene
39	1.89	152	$C_{10}H_{22}$ isomer
39A	1.90	153	C_9H_{16} isomer
40	1.91	154	$C_{10}H_{22}$ isomer
40A	1.91	154	propylcyclohexane
40B	1.91	154	$C_{10}H_{20}$ isomer
41	1.93	155	$C_{10}H_{22}$ isomer
41A	1.94	156	$C_{10}H_{20}$ isomer
42	1.97	158	benzaldehyde
42A	1.97	158	$C_{10}H_{22}$ isomer
42B	2.00	160	C_3-alkyl benzene isomer
43	2.00	160	$C_{11}H_{24}$ isomer
43A	2.01	161	$C_{10}H_{20}$ isomer
43B	2.01	161	phenol
43C	2.03	162	$C_{11}H_{24}$ isomer
44	2.04	163	sat. hydrocarbon
44A	2.04	163	$C_{10}H_{20}$ isomer

TABLE E4 (CONT'D)

Chromato-graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound	Chromato-graphic Peak No.	Relative Retention Time	Elution Temp. (°C)	Compound
45	2.06	164	$C_{10}H_{20}$ isomer				
45A	2.07	165	$C_{11}H_{22}$ isomer				
46	2.09	166	$C_{10}H_{22}$ isomer				
47	2.10	167	$C_{10}H_{20}$ isomer				
48	2.11	168	$C_{11}H_{24}$ isomer				
48A	2.13	169	$C_{11}H_{22}$ isomer				
49	2.14	170	$C_{11}H_{24}$ isomer				
50	2.16	171	$C_{11}H_{24}$ isomer				
50A	2.16	171	$C_{11}H_{22}$ isomer				
51	2.17	172	$C_{10}H_{20}$ isomer				
51A	2.19	173	$C_{11}H_{22}$ isomer				
52	2.19	173	$C_{11}H_{24}$ isomer				
52A	2.21	175	$C_{11}H_{22}$ isomer				
53	2.23	176	acetophenone + $C_{11}H_{22}$ isomer				
54	2.24	177	$C_{12}H_{26}$ isomer				
54A	2.26	178	decalin or $C_{10}H_{18}$ isomer				
55	2.29	180	sat. hydrocarbon (tent.)				
55A	2.30	181	$C_{11}H_{20}$ isomer				
56	2.30	181	$C_{11}H_{22}$ isomer				
57	2.31	182	$C_{12}H_{24}$ isomer				
58	2.33	183	$C_{12}H_{26}$ isomer				
58A	2.34	184	$C_{11}H_{22}$ isomer				
58B	2.37	186	$C_{11}H_{20}$ isomer				
59	2.40	188	$C_{11}H_{20}$ isomer				
60	2.41	189	$C_{12}H_{20}$ or $C_{11}H_{16}O$ isomer				
61	2.43	190	$C_{11}H_{20}$ isomer				
61A	2.46	192	C_2-alkyl phenol isomer (tent.)				
61B	2.50	195	unsat. hydrocarbon				
62	2.53	197	naphthalene				

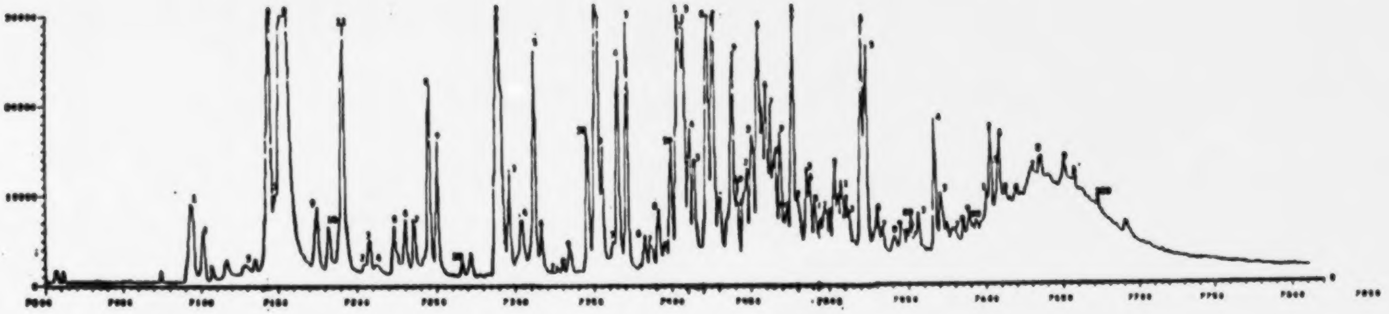

Figure E5. Total ion current plot, IITRI sampler #1, cartridge pair #3, upstream cartridge.

TABLE E5. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #3, IITRI SAMPLER #1

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	52	.46	CO_2
3a	58	.54	butene isomer
3b	58	.54	n-butane
4	59	.56	acetaldehyde
5	66	.66	isopentane
5b	67	.67	acetone
6	69	.70	n-pentane
7	70	.71	diethyl ether (tent.)
8	72	.74	methylene chloride
8a	78	.83	cyclopentane
9	79	.84	2-methylpentane
10	82	.89	3-methylpentane
10a	82	.89	n-butanal
10b	83	.90	methyl vinyl ketone
10c	84	.91	hexafluorobenzene (eS)
10d	84	.91	methyl ethyl ketone
11	85	.93	n-hexane
11a	86	.94	chloroform
12	90	1.00	perfluorotoluene (eS)
13	91	1.01	methylcyclopentane
13a	92	1.03	1,2-dichloroethane
14	93	1.04	tetrahydrofuran
14a	93	1.04	1,1,1-trichloroethane
15	96	1.09	benzene
15a	97	1.10	carbon tetrachloride
15b	98	1.11	cyclohexane
16	99	1.13	2-methylhexane
17	101	1.16	3-methylhexane
18	103	1.19	trichloroethylene
19	105	1.21	n-heptane
20	110	1.29	methylcyclohexane
20a	112	1.31	C_8H_{18} isomer
21	113	1.33	4-methyl-2-pentanone
21a	113	1.33	C_7H_{14} isomer (tent.)
21b	114	1.34	C_8H_{16} isomer
22	118	1.40	toluene
22a	119	1.41	C_8H_{18} isomer
23	121	1.44	C_8H_{18} isomer
23a	122	1.46	$C_6H_{12}O$ isomer
23b	123	1.47	C_8H_{16} isomer
24	123	1.47	C_8H_{16} isomer
24a	125	1.50	C_8H_{16} isomer
25	126	1.51	n-octane
26	128	1.54	C_8H_{16} isomer
26a	128	1.54	tetrachloroethylene
27	131	1.59	C_9H_{20} isomer
28	133	1.61	C_9H_{20} isomer
29	134	1.63	C_9H_{20} isomer
29a	135	1.64	ethylcyclohexane
29b	136	1.66	C_9H_{18} isomer
30	138	1.69	ethylbenzene
31	140	1.71	xylene
31a	140	1.71	C_9H_{20} isomer
32	141	1.73	C_9H_{20} isomer
33	143	1.76	styrene
34	145	1.79	o-xylene
34a	146	1.80	C_9H_{18} isomer
35	147	1.81	n-nonane
36	150	1.86	isopropylbenzene
37	152	1.89	$C_{10}H_{22}$ isomer
38	153	1.90	$C_{10}H_{22}$ isomer
38a	154	1.91	C_9H_{18} isomer
39	155	1.93	$C_{10}H_{22}$ isomer
40	156	1.94	n-propylbenzene
41	157	1.96	ethyltoluene isomer
42	158	1.97	$C_{10}H_{22}$ isomer
43	159	1.99	1,3,5-trimethylbenzene
44	160	2.00	$C_{10}H_{22}$ isomer
45	161	2.01	ethyltoluene isomer
45a	162	2.03	$C_{10}H_{20}$ isomer
45b	163	2.04	α-methylstyrene
46	164	2.06	1,2,4-trimethylbenzene
47	165	2.07	n-decane
47a	166	2.09	$C_{10}H_{20}$ isomer
48	166	2.09	dichlorobenzene isomer
48a	167	2.10	C_3-alkyl benzene isomer
48b	168	2.11	$C_{11}H_{24}$ isomer
48c	169	2.13	C_4-alkyl benzene isomer
48d	169	2.13	$C_{11}H_{24}$ isomer
49	170	2.14	1,2,3-trimethylbenzene
49a	170	2.14	$C_{11}H_{24}$ isomer
50	170	2.14	$C_{11}H_{24}$ isomer
51	171	2.16	indan
52	172	2.17	n-butylcyclohexane
52a	173	2.19	$C_{11}H_{22}$ isomer
53	174	2.20	C_4-alkyl benzene isomer
53a	174	2.20	C_4-alkyl benzene isomer
54	175	2.21	C_4-alkyl benzene isomer
54a	175	2.21	C_4-alkyl benzene isomer
54b	175	2.21	$C_{11}H_{24}$ isomer
54b	176	2.23	C_4-alkyl benzene isomer
55	176	2.23	$C_{11}H_{24}$ isomer

TABLE E5 (CONT'D)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
56	177	2.24	$C_{11}H_{24}$ isomer
56a	177	2.24	C_4-alkyl benzene isomer
57	178	2.26	$C_{11}H_{24}$ isomer
58	179	2.27	C_4-alkyl benzene isomer
59	180	2.29	$C_{11}H_{22}$ isomer
59a	180	2.29	C_4-alkyl benzene isomer
59b	181	2.30	$C_{11}H_{22}$ isomer
60	181	2.30	$C_{11}H_{22}$ isomer
61	182	2.31	*n*-undecane
62	184	2.34	C_4-alkyl benzene isomer
63	186	2.37	$C_{12}H_{26}$ isomer
64	186	2.37	C_4-alkyl benzene isomer
64a	187	2.39	$C_{12}H_{26}$ isomer
65	188	2.40	$C_{11}H_{20}$ isomer
66	189	2.41	C_5-alkyl benzene isomer
66a	189	2.41	$C_{12}H_{24}$ isomer
66b	189	2.41	C_4-alkyl benzene isomer
67	190	2.43	C_5-alkyl benzene isomer
67a	190	2.43	$C_{12}H_{24}$ isomer
68	191	2.44	C_5-alkyl benzene isomer
68a	191	2.44	$C_{12}H_{26}$ isomer
69	192	2.46	C_5-alkyl benzene isomer
70	193	2.47	$C_{12}H_{26}$ isomer
71	193	2.47	C_5-alkyl benzene isomer
72	194	2.49	$C_{12}H_{26}$ and $C_{12}H_{24}$ isomers
73	195	2.50	C_5-alkyl benzene isomer
73a	196	2.51	$C_{12}H_{24}$ isomer
74	197	2.53	naphthalene
75	198	2.54	*n*-dodecane
76	201	2.59	$C_{13}H_{28}$ isomer
77	202	2.60	C_5-alkyl benzene isomer
77a	204	2.63	$C_{13}H_{26}$ isomer
78	205	2.64	C_5-alkyl benzene isomer
78a	206	2.66	$C_{13}H_{26}$ isomer
79	206	2.66	$C_{12}H_{24}$ isomer
80	207	2.67	$C_{13}H_{28}$ and $C_{13}H_{26}$ isomers
81	208	2.69	$C_{13}H_{28}$ isomer
82	209	2.70	$C_{13}H_{28}$ isomer
83	210	2.71	$C_{14}H_{30}$ isomer
83a	211	2.73	$C_{13}H_{26}$ isomer
83b	212	2.74	$C_{13}H_{24}$ isomer
84	213	2.76	*n*-tridecane
85	214	2.77	β-methylnaphthalene
86	216	2.80	$C_{14}H_{30}$ isomer
87	218	2.83	α-methylnaphthalene
88	219	2.84	chloro-fluor compound ? (unknown)
89	221	2.87	$C_{14}H_{28}$ isomer
90	222	2.89	$C_{14}H_{30}$ isomer
90a	224	2.91	$C_{14}H_{26}$ isomer
91	225	2.93	$C_{15}H_{32}$ isomer
92	226	2.94	fluor compound unknown M.W.>300
93	227	2.96	fluor compound unknown M.W.>300
94	227	2.96	*n*-tetradecane
95	229	2.99	$C_{14}H_{26}$ isomer
96	231	3.01	unsat. hydrocarbon
97	235	3.07	unsat. hydrocarbon
98	237	3.10	unsat. hydrocarbon
99	240	3.17	unsat. hydrocarbon

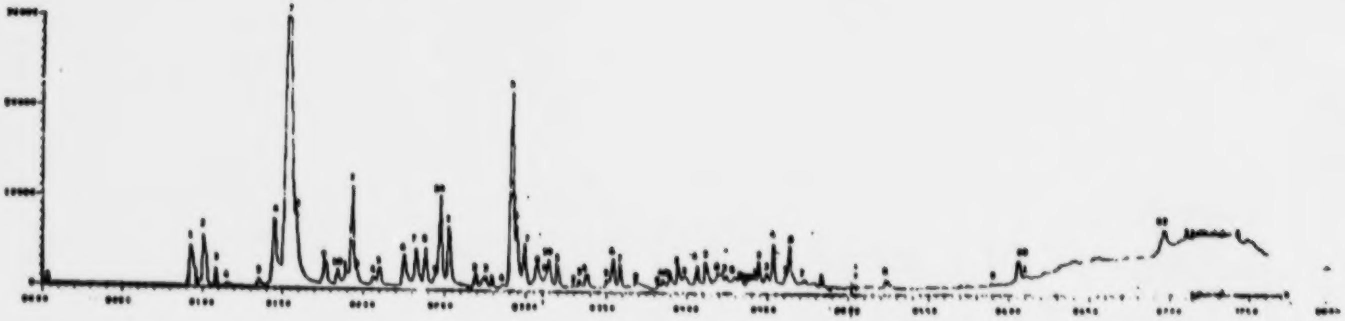

Figure E6. Total ion current plot, IITRI sampler #1, cartridge pair #3, downstream cartridge.

TABLE E6. COMPOUNDS IDENTIFIED IN DOWNSTREAM CARTRIDGE, CARTRIDGE PAIR #3, IITRI SAMPLER #1

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	51	.44	CO_2
3A	58	.54	C_4H_8 isomer
3B	58	.54	n-butane
4	59	.56	acetaldehyde
5	66	.66	isopentane
5B	68	.69	C_2H_6O isomer + propanal (tent)
6	69	.70	n-pentane + acetone
7	72	.74	methylene chloride
9	80	.86	2-methylpentane
10	83	.90	3-methylpentane
10A	84	.91	n-butanal
11	85	.93	hexafluorobenzene (eS)
12	86	.94	n-hexane
13	87	.96	chloroform
13A	88	.97	methyl ethyl ketone (tent)
13B	89	.99	C_6H_{12} isomer
14	90	1.00	perfluorotoluene (eS)
15	91	1.01	methylcyclopentane
15A	93	1.04	1,1,1-trichloroethane
15B	94	1.06	tetrahydrofuran
16	96	1.09	benzene
16A	97	1.10	carbon tetrachloride
16B	98	1.11	cyclohexane
17	99	1.13	2-methylhexane
17A	100	1.14	2,3-dimethylpentane
18	101	1.16	3-methylhexane
19	103	1.19	C_7H_{14} isomer
20	104	1.20	trichloroethylene
21	106	1.23	n-heptane
22	112	1.31	methylcyclohexane
22A	113	1.33	C_8H_{18} isomer
23	114	1.34	C_8H_{18} isomer
23A	115	1.36	4-methyl-2-pentanone
23B	116	1.37	C_8H_{16} isomer
24	118	1.40	C_8H_{16} isomer
25	119	1.41	toluene
26	120	1.43	C_8H_{18} isomer
27	122	1.46	C_8H_{18} isomer
27A	123	1.47	C_8H_{16} isomer
28	124	1.49	C_8H_{16} isomer
28A	125	1.50	C_8H_{16} isomer
29	126	1.51	C_8H_{16} isomer
30	127	1.53	C_8H_{18} isomer
30A	128	1.54	C_8H_{16} isomer
31	129	1.56	tetrachloroethylene + C_8H_{16} isomer
32	133	1.61	C_9H_{20} isomer
33	134	1.63	C_9H_{20} isomer
33A	134	1.63	C_8H_{16} isomer
34	135	1.64	ethylcyclohexane + C_9H_{20} isomer
34A	137	1.67	C_9H_{18} isomer
34B	138	1.69	C_9H_{18} isomer
34C	139	1.70	ethylbenzene
35	139	1.70	C_9H_{20} isomer
36	141	1.73	C_9H_{20} isomer
36A	141	1.73	xylene isomer
37	142	1.74	C_9H_{20} isomer
37A	144	1.77	C_9H_{18} isomer
37B	145	1.79	styrene + heptanal
38	145	1.79	o-xylene
38A	146	1.80	C_9H_{18} isomer
38B	149	1.84	$C_{10}H_{20}$ isomer
39	150	1.86	C_9H_{18} isomer
40	151	1.87	$C_{10}H_{22}$ isomer
41	152	1.89	$C_{10}H_{22}$ isomer
42	154	1.91	$C_{10}H_{22}$ isomer
42A	154	1.91	C_3-alkyl cyclohexane
42B	1.93	1.55	$C_{10}H_{20}$ isomer
43	156	1.94	$C_{10}H_{22}$ isomer
43A	157	1.96	$C_{10}H_{20}$ isomer
43B	157	1.96	benzaldehyde
44	158	1.97	$C_{10}H_{22}$ isomer
45	160	2.00	$C_{10}H_{22}$ isomer
45A	160	2.00	$C_{10}H_{20}$ isomer
45B	161	2.01	phenol
46	162	2.03	$C_{10}H_{22}$ + $C_{10}H_{18}$ (tent) isomers
47	164	2.06	$C_{10}H_{20}$ isomer
47A	165	2.07	$C_{10}H_{20}$ isomer
47B	165	2.07	$C_{11}H_{22}$ isomer
48	166	2.09	n-decane
49	167	2.10	$C_{10}H_{20}$ isomer
50	169	2.13	$C_{11}H_{24}$ isomer
50A	169	2.13	$C_{10}H_{20}$ isomer
51	170	2.14	$C_{11}H_{24}$ isomer
52	171	2.16	$C_{11}H_{24}$ isomer
52A	172	2.17	$C_{11}H_{22}$ isomer
53	173	2.19	$C_{11}H_{24}$ isomer
53A	173	2.19	$C_{10}H_{22}$ isomer

(continued)

TABLE E6 (CONT'D)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound	Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
54	174	2.20	$C_{11}H_{24}$ isomer				
54A	175	2.21	$C_{11}H_{22}$ isomer				
55	177	2.24	acetophenone				
56	178	2.26	$C_{11}H_{24}$ isomer				
56A	179	2.27	$C_{10}H_{18}$ isomer				
56B	179	2.27	$C_{11}H_{22}$ isomer				
56C	180	2.29	$C_{11}H_{22}$ isomer				
57	181	2.30	$C_{11}H_{24}$ isomer				
57A	183	2.33	unsat. hydrocarbon				
57B	184	2.34	$C_{12}H_{24}$ isomer				
58	198	2.54	naphthalene				
58A	216	2.80	methylnaphthalene				
59	221	2.87	fluor-compound + unsat. hydrocarbon				
60	227	2.96	fluor-chloro compound ? (unknown)				
61	229	2.99	fluor-chloro compound ? (unknown)				
62	240	3.39	unsat. hydrocarbon				

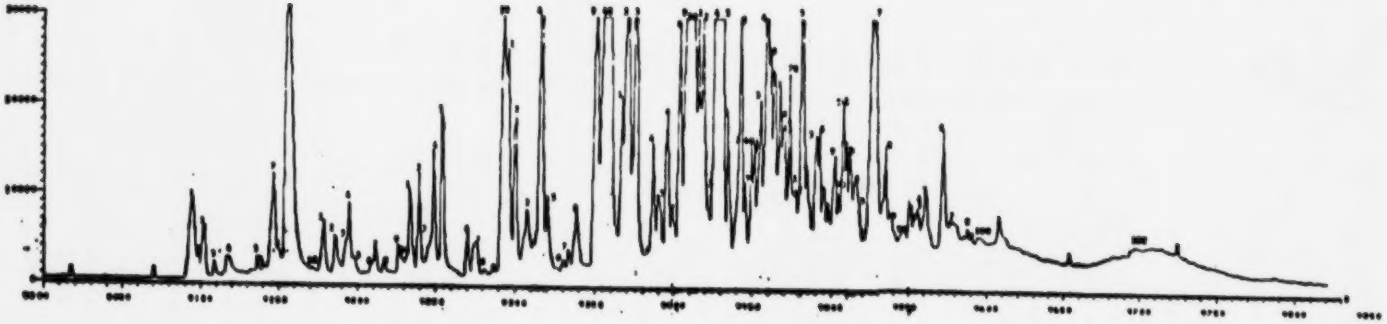

Figure E7. Total ion current plot, IITRI sampler #1, cartridge pair #4, upstream cartridge.

TABLE E7. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #4, IITRI SAMPLER #1

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	52	.45	CO_2
3a	59	.55	C_4H_8 isomer
3b	59	.55	n-butane
4	60	.56	acetaldehyde
5	67	.66	isopentane
6a	68	.68	propenal
6b	69	.69	propenal
7	70	.70	acetone and n-pentane
8	71	.72	$C_4H_{10}O$ isomer (tent.) & C_5H_{10}
-	-	-	isomer
9	73	.75	methylene chloride
9a	75	.77	CS_2 (traces)
10	78	.82	C_4H_8O isomer (tent.)
11	80	.85	2-methylpentane
12	83	.89	3-methylpentane
12a	83	.89	butanal
12b	84	.90	methyl vinyl betone
13	85	.92	hexafluorobenzene (eS) &
-	-	-	methyl ethyl ketone
14	86	.93	n-hexane
15	87	.94	chloroform
15a	90	.99	C_6H_{12} isomer
16	91	1.00	perfluorotoluene (eS)
17	92	1.01	methylcyclopentane
17a	93	1.03	1,2-dichloroethane
18	94	1.04	1,1,1-trichloroethane &
-	-	-	tetrahydrofuran
19	97	1.08	benzene
20	98	1.10	carbon tetrachloride
20a	98	1.10	cyclohexane
21	99	1.11	2-methylhexane
21a	100	1.13	2,3-dimethylpentane
22	101	1.14	3-methylhexane
22a	102	1.15	2-pentanone
22b	102	1.15	C_7H_{14} isomer
23	103	1.17	n-pentanal
23a	104	1.18	C_7H_{14} isomer
24	104	1.18	trichloroethylene
25	106	1.21	n-heptane
25a	108	1.24	C_7H_{14} isomer
26	112	1.30	methylcyclohexane
26a	113	1.31	C_8H_{16} isomer
26b	113	1.31	C_8H_{18} isomer
27	114	1.32	4-methyl-2-pentanone
28	116	1.35	C_8H_{16} isomer
29	117	1.37	C_8H_{16} isomer
30	119	1.39	toluene
31	120	1.41	C_8H_{18} isomer
32	122	1.44	C_8H_{18} isomer
32a	123	1.45	C_8H_{16} isomer
32b	124	1.46	$C_6H_{12}O$ isomer
32c	124	1.46	C_8H_{16} isomer
33	125	1.48	C_8H_{16} isomer
33a	126	1.49	C_8H_{16} isomer
34	127	1.51	n-octane
34a	128	1.52	C_8H_{16} isomer
35	129	1.54	tetrachloroethylene
36	132	1.58	C_9H_{20} isomer
37	133	1.59	C_9H_{20} isomer
37a	134	1.61	C_8H_{16} isomer
38	135	1.62	C_9H_{20} isomer
38a	135	1.62	ethylcyclohexane
38b	136	1.63	chlorobenzene
38c	137	1.65	C_9H_{18} isomer
38d	138	1.66	$C_7H_{14}O$ isomer (tent.)
39	139	1.68	ethylbenzene
40	142	1.72	xylene & C_9H_{20} isomers
40a	143	1.73	C_9H_{20} isomers
40b	144	1.75	heptanone isomer
41	145	1.76	styrene
42	146	1.77	o-xylene
42a	147	1.79	C_9H_{18} isomer
43	148	1.80	n-nonane
43a	151	1.85	C_9H_{18} isomer
43b	151	1.85	$C_{10}H_{22}$ isomer
44	152	1.86	isopropylbenzene
45	153	1.87	$C_{10}H_{22}$ isomer
45a	154	1.89	$C_{10}H_{22}$ isomer
45b	154	1.89	$C_{10}H_{22}$ isomer
46	155	1.90	propylcyclohexane
46a	155	1.90	$C_{10}H_{20}$ isomer
47	156	1.92	$C_{10}H_{22}$ isomer
47a	157	1.93	$C_{10}H_{20}$ isomer
47b	157	1.93	benzaldehyde
48	157	1.93	n-propylbenzene
49	159	1.96	ethyltoluene isomer
49a	159	1.96	$C_{10}H_{22}$ isomer
49b	160	1.97	$C_{10}H_{22}$ isomer
50	161	1.99	1,3,5-trimethylbenzene
51	162	2.00	$C_{10}H_{22}$ isomer
52	163	2.01	o-ethyltoluene
53	164	2.03	$C_{10}H_{20}$ isomer

TABLE E7 (CONT'D)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
53a	165	2.04	C_3H_5-benzene isomer
54	166	2.06	1,2,4-trimethylbenzene
54a	166	2.06	$C_{10}H_{20}$ isomer
55	167	2.07	*n*-decane
56	168	2.08	dichlorobenzene isomer
56a	169	2.10	C_4-alkyl benzene isomer
56b	170	2.11	$C_{11}H_{24}$ isomer
57	170	2.11	C_4-alkyl benzene & $C_{11}H_{24}$
-	-	-	isomers
57a	171	2.13	1,2,3-trimethylbenzene
58	171	2.13	$C_{11}H_{24}$ isomer
59	172	2.14	$C_{11}H_{24}$ isomer
60	173	2.15	indan
61	174	2.17	butylcyclohexane
62	175	2.18	C_4-alkyl benzene isomer
63	175	2.18	C_4-alkyl benzene isomer
64	176	2.20	C_4-alkyl benzene isomer &
-	-	-	acetophenone
64a	177	2.21	$C_{11}H_{24}$ isomer
65	177	2.21	$C_{11}H_{24}$ isomer
66	178	2.23	C_4-alkyl benzene isomer
66a	179	2.24	$C_{11}H_{24}$ isomer
67	179	2.24	C_4-alkyl benzene isomer
68	180	2.25	C_4-alkyl benzene isomer
69	180	2.25	$C_{12}H_{26}$ isomer
70	181	2.27	C_4-alkyl benzene isomer
70a	182	2.28	C_4H_7-benzene isomer
71	182	2.28	$C_{11}H_{22}$ isomer
72	183	2.30	$C_{11}H_{22}$ isomer
73	184	2.31	*n*-undecane
73a	185	2.32	C_4-alkyl benzene isomer
74	185	2.32	$C_{11}H_{22}$ & C_5-alkyl benzene
-	-	-	isomers
74a	186	2.34	$C_{12}H_{26}$ isomer
75	187	2.35	C_4-alkyl benzene isomer
76	188	2.37	C_4-alkyl benzene isomer
77	189	2.38	$C_{12}H_{26}$ isomer
77a	189	2.38	$C_{11}H_{20}$ isomer
78	189	2.38	C_5-alkyl benzene isomer
78a	190	2.39	$C_{12}H_{24}$ isomer
78b	190	2.39	C_5-alkyl benzene isomer
78c	191	2.41	C_4H_7-benzene isomer
79	191	2.41	C_5-alkyl cyclohexane isomer
80	192	2.42	C_5-alkyl benzene isomer
80a	192	2.42	C_4H_7-benzene isomer
81	193	2.44	$C_{12}H_{26}$ isomer
81a	193	2.44	C_4-alkyl benzene isomer
82	193	2.44	C_5-alkyl benzene & $C_{12}H_{26}$
-	-	-	isomers
82a	194	2.45	$C_{12}H_{26}$ isomers
83	194	2.45	C_5-alkyl benzene isomer
84	196	2.48	C_5-alkyl benzene isomer
85	196	2.48	$C_{13}H_{28}$ isomer
86	197	2.49	$C_{13}H_{26}$ isomer (tent.)
87	199	2.52	naphthalene
87a	199	2.52	*n*-dodecane
87b	201	2.55	C_5-alkyl benzene isomer
88	202	2.56	$C_{13}H_{28}$ isomer
89	204	2.59	C_6-alkyl benzene isomer
90	206	2.62	$C_{13}H_{26}$ isomer
90a	207	2.63	$C_{13}H_{26}$ isomer
91	208	2.65	C_6-alkyl cyclohexane isomer
91a	208	2.65	$C_{13}H_{28}$ isomer
92	209	2.66	$C_{13}H_{28}$ isomer
93	209	2.66	$C_{13}H_{28}$ & $C_{13}H_{26}$ isomers
94	210	2.68	$C_{13}H_{28}$ isomer
95	211	2.69	$C_{14}H_{30}$ isomer
95a	212	2.70	$C_{13}H_{26}$ isomer
95b	213	2.72	$C_{14}H_{28}$ isomer
96	215	2.75	*n*-tridecane
97	217	2.77	β-methylnaphthalene
97a	218	2.79	$C_{14}H_{30}$ isomer
97b	219	2.80	α-methylnaphthalene
98	220	2.82	$C_{14}H_{28}$ isomer
99	221	2.83	$C_{14}H_{28}$ & $C_{14}H_{30}$ isomers
100	223	2.86	$C_{14}H_{28}$ & $C_{14}H_{30}$ isomers
101	227	2.92	unknown
102	240	3.34	unsat. hydrocarbons

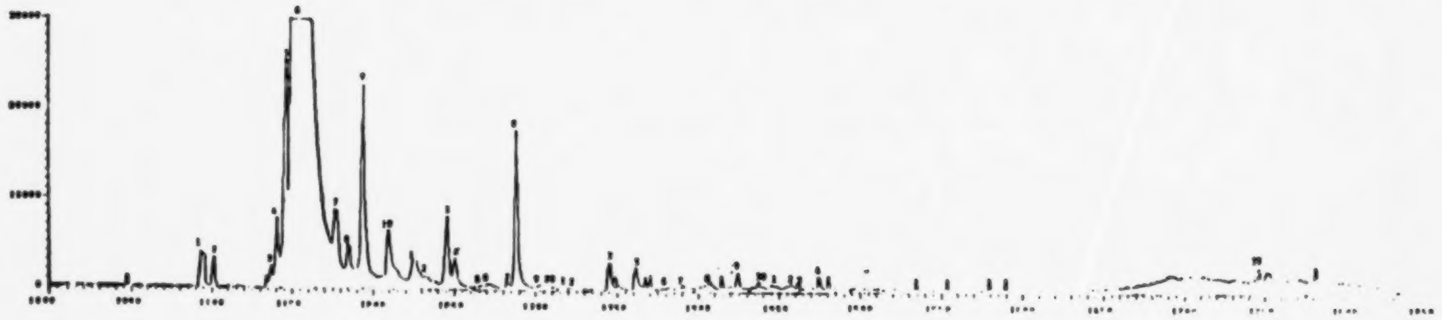

Figure E8. Total ion current plot, IITRI sampler #2, cartridge pair #1, upstream cartridge (blank).

TABLE E8. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #1, IITRI SAMPLER #2 (BLANK)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	52	.46	CO_2
2b	59	.56	C_4H_8 and C_4H_{10} isomers
2c	60	.57	C_4H_{10} isomer
2d	61	.59	acetaldehyde
3	67	.67	isopentane
4	68	.69	acetone
5	70	.71	*n*-pentane
6	71	.73	methylene chloride
6a	80	.86	cyclopentane
7	81	.87	2-methylpentane
8	83	.90	3-methylpentane
8a	84	.91	hexafluorobenzene (eI)
9	86	.94	*n*-hexane
9a	87	.96	chloroform
9b	89	.99	2-butanone
9c	90	1.00	perfluorotoluene (eI)
10	91	1.01	tetrahydrofuran
10a	93	1.04	1,1,1-trichloroethane
10b	96	1.09	benzene
11	97	1.10	carbon tetrachloride
11a	98	1.11	cyclohexane
11b	99	1.13	C_6H_{12} isomer
12	100	1.14	2,3-dimethylpentane
12a	101	1.16	C_6H_{12} isomer
13	104	1.20	$C_5H_{10}O$ isomer
13a	105	1.21	trichloroethylene
14	106	1.23	*n*-heptane
15	111	1.30	C_7H_{14} isomer
16	112	1.31	C_8H_{18} isomer
16a	113	1.33	$C_6H_{12}O$ isomer
17	117	1.39	C_8H_{18} isomer
18	119	1.41	toluene
18a	121	1.44	C_8H_{18} isomer
19	123	1.47	C_8H_{18} isomer
19a	125	1.50	C_8H_{16} isomer
20	126	1.51	*n*-octane
20a	127	1.53	C_8H_{16} isomer
21	128	1.54	tetrachloroethylene
22a	133	1.61	C_9H_{20} isomer
22b	134	1.63	C_8H_{16} isomer
23	138	1.69	ethylbenzene
24	140	1.71	xylene isomer
25	144	1.77	styrene
25a	146	1.80	C_9H_{18} isomer
25b	147	1.81	C_9H_{18} isomer
25c	147	1.81	*n*-nonane
25d	150	1.86	C_9H_{18} isomer
26	151	1.87	isopropylbenzene
26a	152	1.89	C_9H_{18} isomer
27	154	1.91	C_9H_{18} isomer
27a	154	1.91	C_9H_{18} and $C_{10}H_{22}$ isomers
27b	155	1.93	C_9H_{18} isomer
27c	156	1.94	$C_{10}H_{20}$ isomer
27d	157	1.96	*n*-propylbenzene
27e	158	1.97	$C_{10}H_{22}$ isomer
27f	158	1.97	ethyltoluene isomer
27g	159	1.99	$C_{10}H_{20}$ isomer
28	159	1.99	$C_{10}H_{22}$ isomer
28a	160	2.00	$C_{10}H_{18}$ isomer
28b	160	2.00	$C_{10}H_{20}$ isomer
28c	162	2.03	$C_{10}H_{20}$ isomer
28d	164	2.06	ethyltoluene isomer
28c	164	2.06	$C_{10}H_{20}$ isomer
29	165	2.07	*n*-decane
29a	166	2.09	$C_{10}H_{20}$ isomer
29b	169	2.13	$C_{11}H_{22}$ isomer
30	169	2.13	$C_{11}H_{24}$ isomer
30a	170	2.14	$C_{11}H_{24}$ isomer
30b	171	2.16	$C_{10}H_{20}$ and $C_{11}H_{24}$ isomers
31	172	2.17	$C_{10}H_{20}$ isomer
31a	172	2.17	$C_{11}H_{22}$ isomer
31b	173	2.19	$C_{11}H_{24}$ isomer
31c	174	2.20	$C_{11}H_{22}$ isomer
31d	175	2.21	$C_{11}H_{24}$ isomer
31e	176	2.23	$C_{11}H_{22}$ isomer
32	176	2.23	$C_{11}H_{24}$ isomer
33	177	2.24	$C_{11}H_{22}$ isomer
33a	179	2.27	$C_{11}H_{24}$ isomer
33b	180	2.29	$C_{11}H_{20}$ isomer
33c	181	2.30	$C_{11}H_{22}$ isomer
34	182	2.31	*n*-undecane
34a	182	2.33	$C_{11}H_{22}$ isomer
34b	187	2.39	$C_{11}H_{20}$ isomer
34c	188	2.40	$C_{11}H_{20}$ and $C_{12}H_{26}$ isomers
34d	190	2.43	$C_{11}H_{22}$ isomer
34e	191	2.44	$C_{11}H_{20}$ isomer
34f	192	2.46	$C_{12}H_{26}$ and $C_{12}H_{24}$ isomers
34g	194	2.49	$C_{12}H_{24}$ isomer
34h	197	2.53	naphthalene
34i	198	2.54	*n*-dodecane
34j	199	2.56	unsat. hydrocarbon
35	240	3.66	sat. hydrocarbon

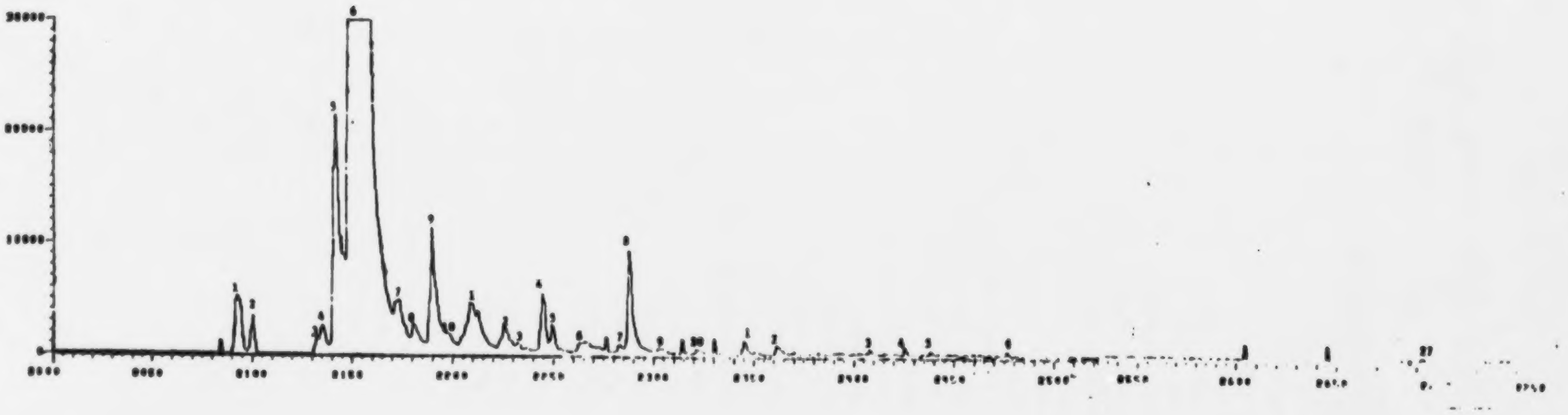

Figure E9. Total ion current plot, IITRI sampler #2, cartridge pair #1, downstream cartridge (blank).

TABLE E9. COMPOUNDS IDENTIFIED IN DOWNSTREAM CARTRIDGE, CARTRIDGE PAIR #1, IITRI SAMPLER #2 (BLANK)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	51	.44	CO_2
2a	58	.54	C_4H_8 isomer
2b	59	.56	C_4H_{10} isomer
2c	61	.59	acetaldehyde
3	65	.64	isopentane
4a	67	.67	dimethyl ether
5	68	.69	n-pentane
5a	69	.70	acetone
6	70	.71	methylene chloride
7	79	.84	C_5H_{10} isomer
7a	79	.84	cyclopentane
8	82	.89	3-methylpentane
8a	84	.91	hexafluorobenzene (eS)
9	85	.93	n-hexane and C_6H_{12} isomer
9a	86	.94	chloroform
10	88	.97	2-butanone
10a	90	1.00	perfluorotoluene (eS)
10b	91	1.01	methylcyclopentane
11	91	1.01	tetrahydrofuran
11a	93	1.04	1,1,1-trichloroethane
11b	96	1.09	benzene
12	97	1.10	carbon tetrachloride
12a	98	1.11	cyclohexane
13	99	1.13	2,3-dimethylhexane
13a	100	1.14	C_6H_{12} isomer
13b	104	1.20	$C_5H_{10}O$ and C_7H_{14} isomers
13c	104	1.20	C_7H_{14} isomer
14	104	1.20	trichloroethylene
15	106	1.23	n-heptane
16	111	1.30	unknown
16a	113	1.33	C_8H_{18} isomer
16b	115	1.36	$C_6H_{12}O$ isomer
17	117	1.39	C_8H_{18} isomer
18	119	1.41	toluene
19	124	1.49	C_8H_{18} isomer
19a	127	1.53	n-octane
19b	129	1.56	tetrachloroethylene
20	130	1.57	acetic acid (tent.)
21	138	1.69	ethylbenzene
21a	140	1.71	xylene isomer
22	144	1.77	styrene
22a	146	1.80	C_9H_{18} isomer
22b	147	1.81	n-nonane
22c	150	1.86	C_9H_{18} isomer
22d	151	1.87	$C_{10}H_{22}$ isomer
22e	151	1.87	isopropylbenzene
22f	154	1.91	C_9H_{18} and $C_{10}H_{22}$ isomers
22g	157	1.96	n-propylbenzene
22h	158	1.97	$C_{10}H_{22}$ isomer
22i	158	1.97	ethyltoluene isomer
22j	158	1.97	$C_{10}H_{22}$ isomer
23	159	1.99	$C_{10}H_{22}$ isomer
23a	160	2.00	$C_{10}H_{20}$ isomer
23b	162	2.03	$C_{10}H_{22}$ isomer
23c	163	2.04	$C_{10}H_{20}$ isomer
23d	164	2.06	ethytoluene isomer
23e	164	2.06	$C_{10}H_{20}$ isomer
24	165	2.07	n-decane
24a	166	2.09	$C_{10}H_{20}$ isomer
25	169	2.13	$C_{11}H_{24}$ isomer
25a	170	2.14	$C_{10}H_{20}$ isomer
25b	172	2.17	$C_{10}H_{20}$ and $C_{11}H_{22}$ isomers
25c	173	2.19	$C_{11}H_{24}$ isomer
25d	173	2.19	$C_{11}H_{22}$ isomer
25e	176	2.23	$C_{11}H_{24}$ isomer
25f	178	2.26	$C_{10}H_{18}$ isomer
25g	179	2.27	$C_{11}H_{22}$ isomer
25h	180	2.29	$C_{11}H_{22}$ isomer
26	182	2.31	n-undecane
26a	187	2.39	$C_{11}H_{20}$ isomer
26b	190	2.43	$C_{12}H_{24}$ isomer
27	240	3.37	sat. hydrocarbon

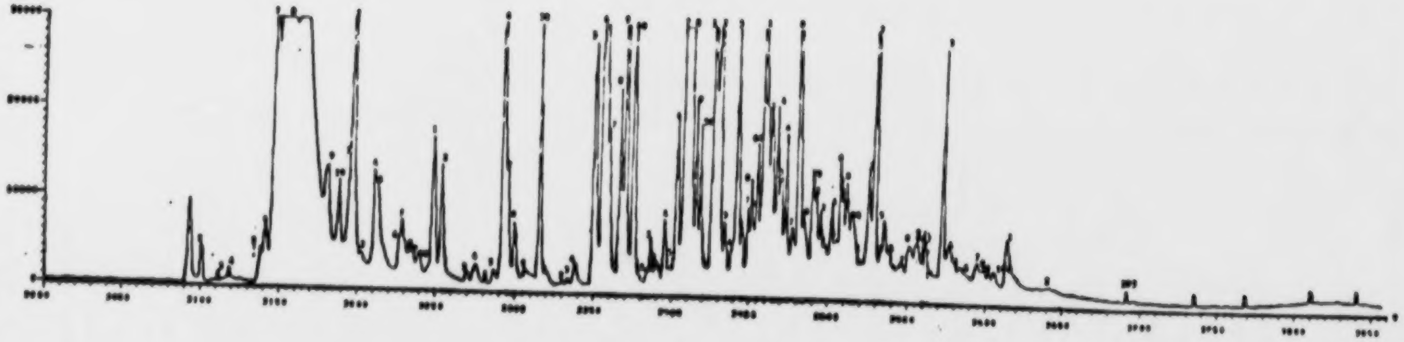

Figure E10. Total ion current plot, IITRI sampler #2, cartridge pair #2, upstream cartridge.

TABLE E10. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE PAIR, CARTRIDGE PAIR #2, IITRI SAMPLER #2

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	51	.44	CO_2
2A	54	.48	chloromethane
2B	55	.49	propane
2C	56	.51	butene
3	57	.52	butane
3A	59	.55	acetaldehyde
4	60	.57	alcohol (tent)
5	67	.66	isopentane
7	70	.70	n-pentane
8	72	.73	methylene chloride
8A	73	.75	acetone (tent)
9	82	.87	2-methylpentane
10	84	.90	3-methylpentane
10A	85	.92	C_6H_{12} isomer
11	86	.93	hexafluorobenzene (eI) + methyl ethyl ketone
12	87	.94	n-hexane
12A	88	.96	chloroform
13	89	.97	ethyl acetate
13A	91	1.00	perfluorotoluene (eI)
14	92	1.01	tetrahydrofuran
15	92	1.01	C_6H_{12} isomer + 1,2-dichloroethane
15A	94	1.04	1,1,1-trichloroethane
16	97	1.08	benzene
17	98	1.10	carbon tetrachloride
17A	99	1.11	cyclohexane
18	99	1.11	2-methylhexane
19	100	1.13	2,3-dimethylpentane
20	101	1.14	3-methylhexane
20A	103	1.17	C_7H_{14} isomer
20B	104	1.18	n-pentanal
21	104	1.18	trichloroethylene + C_8H_{18} isomer
22	106	1.21	n-heptane
23	112	1.30	methylcyclohexane
23A	113	1.31	C_8H_{18} isomer
24	114	1.32	4-methyl-2-pentanone + C_8H_{18} isomer
24A	116	1.35	C_8H_{16} isomer
25	117	1.37	C_8H_{18} isomer
26	119	1.39	toluene
27	120	1.41	C_8H_{18} isomer
28	122	1.44	C_8H_{18} isomer
28A	123	1.45	C_8H_{16} isomer
29	124	1.46	C_8H_{16} + $C_6H_{12}O$ (tent) isomers
29A	126	1.49	C_8H_{16} isomer
30	127	1.51	n-octane
31	129	1.54	tetrachloroethylene
32	133	1.59	C_9H_{20} isomer
32A	133	1.59	C_8H_{16} isomer
33	134	1.61	C_9H_{20} isomer
34	135	1.62	ethylcyclohexane + C_8H_{18} isomer
34A	136	1.63	C_9H_{18} + alcohol (tent) isomers
34B	138	1.66	C_9H_{18} isomer
35	139	1.68	ethylbenzene
35A	141	1.70	C_9H_{20} isomer
36	141	1.70	xylene isomer
37	142	1.72	C_9H_{20} isomer
37A	144	1.75	heptanone isomer
38	145	1.76	styrene
39	146	1.77	o-xylene
39A	147	1.79	C_9H_{20} isomer
40	148	1.80	n-nonane
41	150	1.83	C_9H_{18} isomer
41A	151	1.85	$C_{10}H_{22}$ isomer
42	151	1.85	isopropylbenzene
43	153	1.87	$C_{10}H_{22}$ isomer
44	154	1.89	propylcyclohexane + $C_{10}H_{22}$ isomer
45	155	1.90	$C_{10}H_{20}$ isomer
45A	156	1.92	benzaldehyde
46	157	1.93	n-propylbenzene
47	159	1.96	ethyltoluene isomer
47A	159	1.96	$C_{10}H_{22}$ isomer
48	160	1.97	C_3-alkyl benzene + $C_{10}H_{22}$ isomers
49	161	1.99	$C_{10}H_{22}$ isomer
50	163	2.01	o-ethyltoluene
50A	164	2.03	$C_{10}H_{20}$ isomer
50B	165	2.04	C_3H_5-benzene isomer
51	166	2.06	1,2,4-trimethylbenzene
52	167	2.07	n-decane
53	168	2.08	dichlorobenzene + C_4-alkyl benzene isomers
53A	169	2.10	C_4-alkyl benzene isomer
54	170	2.11	C_4-alkyl benzene + $C_{11}H_{24}$ isomers
54A	170	2.11	1,2,3-trimethylbenzene
55	171	2.13	$C_{11}H_{24}$ isomer
56	172	2.14	$C_{11}H_{24}$ isomer

TABLE E10 (CONT'D)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
57	173	2.15	indan
58	174	2.17	butylcyclohexane
59	175	2.18	C_4-alkyl brnzene isomer
60	175	2.18	C_4-alkyl benzene isomer
60A	176	2.20	C_4-alkyl benzene isomer
61	176	2.20	acetophenone
61A	177	2.21	$C_{11}H_{24}$ isomer
62	177	2.21	$C_{11}H_{24}$ isomer
63	178	2.23	C_4-alkyl benzene isomer
63A	179	2.24	$C_{11}H_{24}$ isomer
64	179	2.24	C_4-alkyl benzene + $C_{11}H_{22}$ isomers
65	180	2.25	C_4-alkyl benzene isomer
66	181	2.27	C_4-alkyl benzene isomer
66A	182	2.28	C_4H_7-benzene isomer
67	182	2.28	$C_{11}H_{22}$ isomer
68	183	2.30	*n*-undecane
69	185	2.32	C_4-alkyl benzene + $C_{11}H_{22}$ isomers
69A	186	2.34	$C_{12}H_{26}$ isomer
70	187	2.35	$C_{12}H_{26}$ isomer
71	188	2.37	C_4-alkyl benzene isomer
72	189	2.38	$C_{12}H_{26}$ isomer
72A	189	2.38	$C_{11}H_{20}$ isomer
73	190	2.39	C_5-alkyl benzene isomer
73A	190	2.39	C_5-alkyl benzene isomer
73B	191	2.41	C_5H_9-benzene isomer (traces)
74	191	2.41	C_5-alkyl cyclohexane isomer
75	192	2.42	C_5-alkyl benzene isomer
76	193	2.44	$C_{12}H_{26}$ isomer
77	193	2.44	$C_{12}H_{26}$ + C_5-alkyl benzene isomers
78	194	2.45	$C_{12}H_{26}$ isomer
79	195	2.46	C_5-alkyl benzene isomer
80	196	2.48	C_5-alkyl benzene + $C_{13}H_{28}$ isomers
81	197	2.49	C_4-alkyl benzene + $C_{12}H_{24}$ isomers
82	198	2.51	naphthalene
82A	199	2.52	$C_{12}H_{24}$ isomer
83	199	2.52	*n*-dodecane
84	201	2.55	C_5-alkyl benzene + $C_{12}H_{24}$ isomers
85	202	2.56	$C_{13}H_{28}$ isomer
86	203	2.58	C_6-alkyl benzene + $C_{13}H_{28}$ isomers
87	206	2.62	$C_{13}H_{26}$ isomer
87A	207	2.63	$C_{13}H_{26}$ isomer
88	207	2.63	C_6-alkyl cyclohexane + C_6-alkyl benzene isomers
88A	208	2.65	$C_{13}H_{28}$ isomer
89	209	2.66	C_6-alkyl benzene isomer
90	209	2.66	$C_{13}H_{28}$ isomer
91	210	2.68	$C_{13}H_{28}$ isomer
92	211	2.69	$C_{14}H_{30}$ isomer
93	214	2.73	*n*-tridecane
94	216	2.76	β-methylnaphthalene
94A	217	2.77	$C_{13}H_{26}$ isomer
95	217	2.77	$C_{14}H_{30}$ isomer
96	218	2.79	α-methylnaphthalene
96A	220	2.82	$C_{14}H_{28}$ isomer
96B	221	2.83	$C_{14}H_{30}$ isomer
97	222	2.84	C_7-alkyl cyclohexane isomer
98	223	2.86	$C_{14}H_{30}$ isomer
99	224	2.87	sat. hydrocarbon
100	226	2.90	sat. hydrocarbon
100A	227	2.92	$C_{14}H_{28}$ isomer
101	228	2.93	*n*-tetradecane
101A	232	2.99	C_2-alkyl naphthalene isomer
101B	234	3.01	$C_{15}H_{32}$ isomer
101C	234	3.01	$C_{15}H_{30}$ + C_2-alkyl naphthalene isomers
102	238	3.07	$C_{15}H_{32}$ + C_2-alkyl naphthalene isomers
103	240	3.34	sat. hydrocarbon

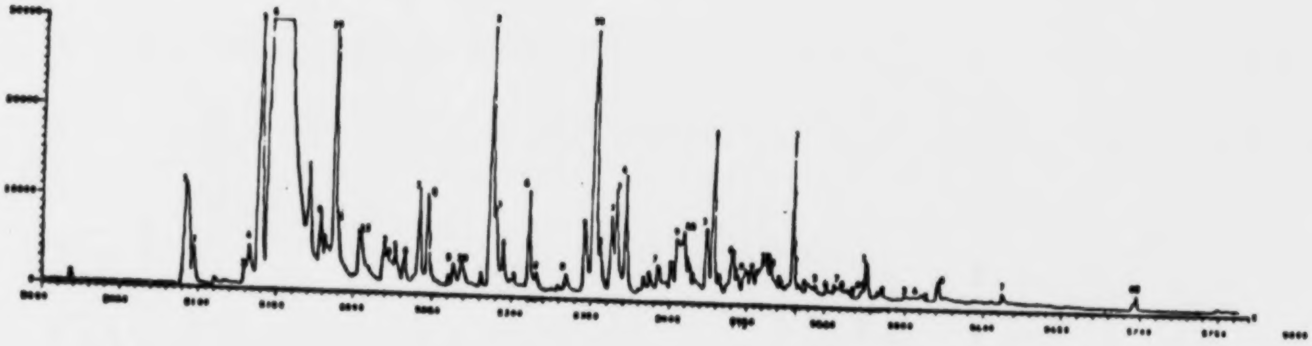

Figure E11. Total ion current plot, IITRI sampler #2, cartridge pair #3, upstream cartridge.

TABLE E11. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #1, IITRI SAMPLER #2 (BLANK)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	51	.46	CO_2
2a	57	.55	C_4H_{10} isomer
2b	58	.57	C_4H_8 isomer
2c	60	.60	acetaldehyde
3	64	.66	isopentane
5	66	.69	n-pentane
5a	68	.72	acetone
6	68	.72	methylene chloride
6a	77	.85	cyclopentane
7	78	.87	2-methylpentane
8	80	.90	3-methylpentane
9	81	.91	2-butanone
9a	82	.93	hexafluorobenzene (eS)
10	83	.94	n-hexane
11	84	.96	chloroform
11a	85	.97	ethyl acetate (tent.)
11b	87	1.00	perfluorotoluene (eS)
11c	88	1.01	methylcyclopentane
12	89	1.03	tetrahydrofuran
12a	90	1.04	1,2-dichloroethane
12b	91	1.06	1,1,1-trichloroethane
13	94	1.10	benzene
14	95	1.12	carbon tetrachloride
14a	96	1.13	cyclohexane
15	97	1.15	3-methylhexane
15a	98	1.16	2,3-dimethylpentane
16	99	1.18	3-methylhexane
16a	100	1.19	C_7H_{16} isomer
16b	101	1.21	$C_5H_{10}O$ & C_7H_{14} isomers
17	102	1.22	trichloroethylene
18	104	1.25	n-heptane
18a	108	1.31	C_7H_{14} isomer
19	110	1.34	methylcyclohexane
20	111	1.36	C_8H_{18} isomer
20a	112	1.37	4-methyl-2-pentanone
20b	113	1.39	C_7H_{14} isomer
20c	114	1.40	C_8H_{16} isomer
20d	115	1.42	C_8H_{16} isomer
21	116	1.43	C_8H_{18} isomer
22	117	1.45	toluene
23	118	1.46	C_8H_{18} isomer
24	120	1.49	C_8H_{18} isomer
25	122	1.52	dimethylcyclohexane isomer
25a	122	1.52	C_8H_{18} isomer
25b	123	1.54	C_8H_{16} isomer
25c	125	1.57	C_8H_{16} isomer
26	126	1.58	n-octane
27	127	1.60	tetrachloroethylene
27b	130	1.64	C_9H_{20} isomer
27c	132	1.67	C_9H_{20} isomer
27d	133	1.69	C_8H_{16} isomer
27e	133	1.69	C_9H_{20} isomer
28	134	1.70	ethylcyclohexane
28a	135	1.72	C_9H_{18} isomer
28b	137	1.75	C_9H_{18} isomer
29	138	1.76	ethylbenzene
30	140	1.79	xylene isomer
31	141	1.81	C_9H_{20} isomer
31a	143	1.84	2-heptanone
32	144	1.85	styrene
33	145	1.87	o-xylene
33a	146	1.88	C_9H_{18} isomer
34	147	1.90	n-nonane
34a	148	1.91	C_9H_{18} isomer
34b	150	1.94	C_9H_{18} isomer
35	151	1.96	$C_{10}H_{22}$ isomer
35a	151	1.96	isopropylbenzene
36	152	1.97	$C_{10}H_{22}$ isomer
37	154	2.00	$C_{10}H_{22}$ isomer
37a	154	2.00	C_9H_{18} isomer
37b	155	2.01	$C_{10}H_{20}$ isomer
37c	156	2.03	$C_{10}H_{20}$ isomer
37d	156	2.03	$C_{10}H_{22}$ isomer
38	157	2.04	benzaldehyde & n-propylbenzene
39	158	2.06	ethyltoluene isomer
39a	159	2.07	$C_{10}H_{22}$ isomer
40	159	2.07	1,3,5-trimethylbenzene
40a	160	2.09	$C_{10}H_{22}$ isomer
41	161	2.10	$C_{10}H_{20}$ isomer
41a	161	2.10	$C_{10}H_{22}$ isomer
42	162	2.12	o-ethyltoluene
42a	163	2.13	$C_{11}H_{24}$ isomer
42b	163	2.13	$C_{10}H_{20}$ isomer
42c	164	2.15	$C_{10}H_{18}$ isomer
43	165	2.16	1,2,4-trimethylbenzene
43a	165	2.16	$C_{10}H_{20}$ isomer
44	166	2.18	n-decane
44a	167	2.19	$C_{10}H_{20}$ isomer
45	167	2.19	dichlorobenzene
45a	168	2.21	C_4-alkyl benzene isomer
45b	169	2.22	$C_{11}H_{24}$ isomer
45c	169	2.22	C_4-alkyl benzene isomer

TABLE E11 (CONT'D)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
46	170	2.24	1,2,3-trimethylbenzene
46a	170	2.24	$C_{11}H_{24}$ isomer
47	171	2.25	$C_{11}H_{24}$ isomer
47a	172	2.27	$C_{11}H_{22}$ isomer
47b	172	2.27	indan (traces)
48	173	2.28	butylcyclohexane
48a	173	2.28	$C_{11}H_{22}$ isomer
49	174	2.30	C_4-alkyl benzene & $C_{11}H_{24}$ isomers
49a	174	2.30	$C_{11}H_{22}$ isomers
49b	175	2.31	C_4-alkyl benzene isomer
49c	176	2.33	$C_{11}H_{24}$ isomer
49d	176	2.33	acetophenone
50	177	2.34	$C_{11}H_{24}$ isomer
51	179	2.37	$C_{10}H_{18}$ isomer
51a	180	2.39	C_4-alkyl benzene isomer
51b	181	2.40	$C_{11}H_{22}$ isomer
52	181	2.40	C_4-alkyl benzene isomer
52a	182	2.42	$C_{11}H_{22}$ isomer
53	184	2.45	*n*-undecane
53a	185	2.46	$C_{11}H_{22}$ isomer
53b	186	2.48	$C_{12}H_{26}$ isomer
53c	186	2.48	$C_{11}H_{22}$ isomer
53d	187	2.49	$C_{12}H_{26}$ isomer
54	188	2.51	C_4-alkyl benzene isomer
55	189	2.52	$C_{11}H_{20}$ isomer
55a	190	2.54	C_5-alkyl benzene isomer
56	191	2.55	$C_{12}H_{24}$ isomer
56a	191	2.55	C_5-alkyl cyclohexane isomer
56b	192	2.57	$C_{11}H_{18}$ isomer
56c	192	2.57	$C_{12}H_{24}$ isomer
57	193	2.58	$C_{12}H_{26}$ isomer
57a	193	2.58	$C_{12}H_{26}$ & C_4-alkylbenzene
57b	194	2.60	C_5-alkyl benzene isomer
58	194	2.60	$C_{12}H_{26}$ isomer
58a	194	2.60	C_5-alkylbenzene isomer
58b	195	2.61	$C_{12}H_{26}$ isomer
59	195	2.61	C_5-alkyl benzene isomer
59a	196	2.63	$C_{12}H_{24}$ isomer
59b	197	2.64	$C_{12}H_{22}$ isomer
60	198	2.66	napthalene
61	199	2.67	*n*-dodecane
61a	200	2.69	$C_{12}H_{22}$ isomer
62	202	2.72	$C_{13}H_{28}$ isomer
62a	203	2.73	C_6-alkyl benzene isomer
62b	204	2.75	$C_{12}H_{22}$ isomer
62c	205	2.76	$C_{12}H_{24}$ isomer
63	208	2.81	C_6-alkyl cyclohexane &
-	-	-	$C_{12}H_{24}$ isomers
63a	209	2.82	$C_{13}H_{26}$ isomer
64	210	2.84	$C_{13}H_{28}$ isomer
64a	210	2.84	$C_{13}H_{24}$ isomer
65	211	2.85	$C_{13}H_{28}$ isomer
65a	211	2.85	$C_{13}H_{26}$ isomer
65b	212	2.87	C_6-alkyl benzene isomer
65c	213	2.88	$C_{13}H_{26}$ isomer
65d	213	2.88	$C_{13}H_{24}$ isomer
66	214	2.90	*n*-tridecane
66a	215	2.91	β-methylnaphthalene
66b	216	2.93	$C_{13}H_{26}$ isomer
66c	217	2.94	α-methylnaphthalene
66d	219	2.97	$C_{14}H_{28}$ isomer
67	229	3.12	*n*-tetradecane
67a	230	3.13	$C_{14}H_{26}$ isomer
68	240	3.54	sat. hydrocarbon

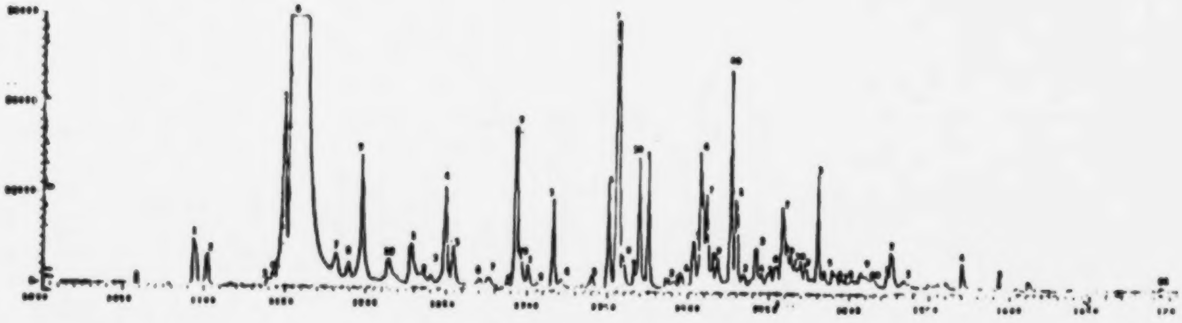

Figure E12. Total ion current plot, IITRI sampler #2, cartridge pair #4, upstream cartridge.

TABLE E12. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #4, IITRI SAMPLER #2

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	52	.45	CO_2
2a	59	.55	C_4H_8 isomer
2b	59	.55	acetaldehyde
2c	60	.56	C_4H_{10} isomer
3	68	.68	isopentane
4a	70	.70	dimethyl ether (tent.)
4b	70	.70	acetone
5	71	.72	*n*-pentane
6	72	.73	methylene chloride
6a	81	.86	cyclopentane
7	82	.87	2-methylpentane
8	84	.90	3-methylpentane
8a	86	.93	hexafluorobenzene (eF)
9	87	.94	*n*-hexane
9a	88	.96	chloroform
9b	89	.97	2-butanone
9c	90	.99	ethyl acetate (tent.)
9d	91	1.00	perfluorotoluene (eF)
9e	92	1.01	methylcyclopentane
10	93	1.03	tetrahydrofuran
10a	93	1.03	1,2-dichloroethane (traces)
10b	94	1.04	1,1,1-trichloroethane (traces)
11	98	1.10	benzene
11a	99	1.11	carbon tetrachloride
12	100	1.13	cyclohexane
12a	101	1.14	2-methylhexane
12b	101	1.14	2,3-dimethylpentane
12c	102	1.15	C_6H_{12} isomer
13	102	1.15	3-methylhexane
13a	103	1.17	C_7H_{14} & $C_5H_{10}O$ isomers
14	105	1.20	trichloroethylene
15	106	1.21	*n*-heptane
16	110	1.27	methylcyclohexane
17	112	1.30	C_8H_{18} isomer
17a	114	1.32	C_8H_{16} isomer
17b	115	1.34	C_8H_{18} isomer
18	118	1.38	C_8H_{18} isomer
19	120	1.41	toluene
20	121	1.42	C_8H_{18} isomer
21	123	1.45	C_8H_{16} isomer
21a	124	1.46	$C_6H_{12}O$ & C_8H_{18} isomers
21b	125	1.48	C_8H_{16} isomer
22	125	1.48	C_8H_{16} isomer
22a	127	1.51	C_8H_{16} isomer
23	128	1.52	*n*-octane
24	130	1.55	tetrachloroethylene
24a	133	1.59	C_9H_{20} isomer
24b	134	1.61	C_9H_{20} isomer
24c	135	1.62	C_8H_{16} isomer
24d	135	1.62	C_9H_{20} isomer
24e	136	1.63	C_8H_{16} isomer
25	136	1.63	chlorobenzene
25a	138	1.66	C_9H_{18} isomer
25b	139	1.68	C_9H_{18} isomer
26	140	1.69	ethylbenzene
27	142	1.72	xylene isomer
28	143	1.73	C_9H_{20} isomer
28a	144	1.75	2-heptanone
29	145	1.76	styrene
30	146	1.77	*o*-xylene
30a	147	1.79	C_9H_{18} isomer
31	148	1.80	*n*-nonane
31a	151	1.85	C_9H_{18} isomer
31b	151	1.85	$C_{10}H_{22}$ isomer
32	152	1.86	isopropylbenzene
32a	153	1.87	$C_{10}H_{22}$ isomer
33	153	1.87	$C_{10}H_{22}$ isomer
33a	154	1.89	C_9H_{18} isomer
34	155	1.90	$C_{10}H_{22}$ isomer
34a	156	1.92	C_9H_{18} & $C_{10}H_{20}$ isomers
34b	157	1.93	$C_{10}H_{22}$ isomer
34c	158	1.94	benzaldehyde
35	158	1.94	*n*-propylbenzene
36	159	1.96	ethyltoluene isomer
36a	160	1.97	$C_{10}H_{22}$ isomer
37	161	1.99	1,3,5-trimethylbenzene
38	162	2.00	$C_{10}H_{22}$ isomer
39	163	2.01	*o*-ethyltoluene
39a	164	2.03	$C_{11}H_{24}$ isomer
39b	164	2.03	$C_{10}H_{20}$ isomer
40	165	2.04	1,2,4-trimethylbenzene
41	166	2.06	*n*-decane
42	168	2.08	dichlorobenzene
42a	168	2.08	C_4-alkyl benzene isomer
42b	169	2.10	$C_{11}H_{24}$ isomer
42c	170	2.11	C_4-alkyl benzene isomer
43	171	2.13	1,2,3-trimethylbenzene
43a	171	2.13	$C_{11}H_{24}$ isomer
44	172	2.14	$C_{11}H_{24}$ isomer
44a	173	2.15	indan
45	173	2.15	butylcyclohexane
45a	174	2.17	$C_{11}H_{22}$ isomer

TABLE E12 (CONT'D)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
45b	174	2.17	C_4-alkyl benzene isomer
46	175	2.18	C_4-alkyl benzene isomer
47	176	2.20	acetophenone
48	177	2.21	$C_{11}H_{24}$ isomer
49	178	2.23	C_4-alkyl benzene isomer
50	179	2.24	$C_{11}H_{24}$ isomer
50a	179	2.24	$C_{11}H_{22}$ isomer
51	180	2.25	C_4-alkyl benzene isomer
51a	181	2.27	$C_{11}H_{22}$ isomer
52	182	2.28	C_4-alkyl benzene isomer
52a	183	2.30	$C_{11}H_{22}$ isomer
53	184	2.31	*n*-undecane
54	185	2.32	$C_{11}H_{22}$ isomer
54a	186	2.34	$C_{12}H_{26}$ isomer
55	187	2.35	C_4-alkyl benzene isomer
55a	187	2.35	$C_{12}H_{26}$ isomer
56	188	2.37	$C_{11}H_{20}$ isomer
57	189	2.38	C_5-alkyl benzene isomer
57a	189	2.38	$C_{12}H_{24}$ isomer
57b	190	2.39	C_5-alkyl benzene isomer
58	191	2.41	$C_{11}H_{22}$ and $C_{12}H_{24}$ isomers
58a	192	2.42	C_5-alkyl benzene & $C_{11}H_{20}$
58b	193	2.44	$C_{12}H_{26}$ isomer
59	193	2.44	C_4-alkyl benzene isomer
59a	193	2.44	$C_{12}H_{26}$ isomers
59b	194	2.45	C_5-alkyl benzene isomer
59c	194	2.45	$C_{12}H_{26}$ isomer
59d	195	2.46	$C_{12}H_{24}$ isomer
60	196	2.48	C_5-alkyl benzene isomer
60a	198	2.51	$C_{12}H_{24}$ and $C_{12}H_{22}$ isomers
61	199	2.52	naphthalene
62	200	2.54	*n*-dodecane
62a	201	2.55	$C_{12}H_{22}$ isomer
62b	202	2.56	$C_{12}H_{24}$ isomer
63	203	2.58	$C_{13}H_{28}$ isomer
63a	204	2.59	C_6-alkyl benzene isomer
63b	205	2.61	$C_{13}H_{26}$ isomer
63c	206	2.62	$C_{12}H_{22}$ isomer
63d	207	2.63	C_6-alkyl benzene isomer
63e	208	2.65	$C_{13}H_{26}$ isomer
63f	209	2.66	$C_{13}H_{28}$ isomer
63g	210	2.68	$C_{13}H_{28}$ & $C_{13}H_{26}$ isomers
63h	211	2.69	$C_{13}H_{28}$ isomer
63i	212	2.70	$C_{13}H_{26}$ isomer
63j	212	2.70	$C_{14}H_{30}$ isomer
63k	213	2.72	C_6-alkyl benzene isomer
63L	214	2.73	$C_{13}H_{24}$ isomer
64	215	2.75	*n*-tridecane
64a	216	2.76	β-methylnaphthalene
64b	217	2.77	$C_{13}H_{26}$ isomer
64c	218	2.79	$C_{13}H_{24}$ isomer
64d	219	2.80	α-methylnaphthalene
64e	221	2.83	$C_{14}H_{28}$ isomer
64f	224	2.87	$C_{14}H_{30}$ isomer
64g	227	2.92	$C_{14}H_{28}$ isomer
64h	228	2.93	$C_{14}H_{28}$ isomer
65	229	2.94	*n*-tetradecane
65a	232	2.99	$C_{14}H_{26}$ isomer
65b	239	3.08	$C_{15}H_{30}$ isomer
66	240	3.34	sat. hydrocarbon

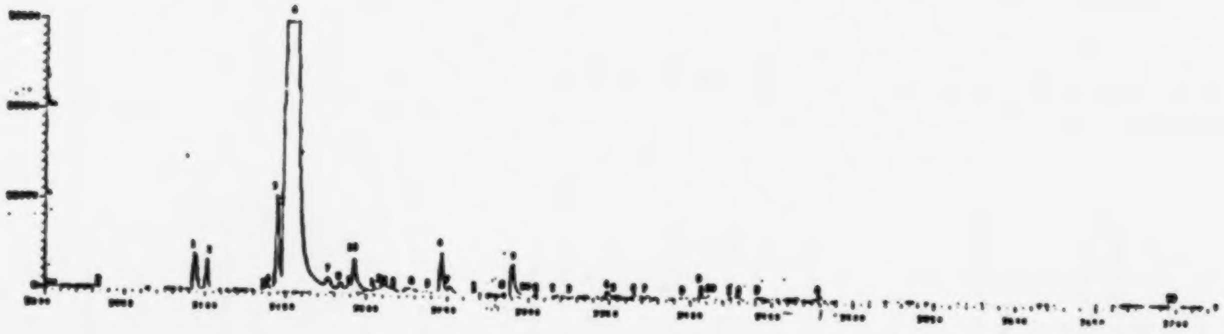

Figure E13. Total ion current plot, IITRI sampler #3, cartridge pair #1, upstream cartridge.

TABLE E13. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #1, IITRI SAMPLER #3

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	52	.46	CO_2
2A	59	.56	C_4H_8 isomer
2B	59	.56	acetaldehyde
3	67	.67	isopentane
5	70	.71	acetone + n-pentane
6	72	.74	methylene chloride
7	80	.86	2-methylpentane
8	83	.90	3-methylpentane
8A	84	.91	butanal (tent)
9	85	.93	hexafluorobenzene (eI)
10	86	.94	n-hexane
10A	87	.96	chloroform
10B	88	.97	ethyl acetate
10C	89	.99	C_6H_{12} isomer
11	90	1.00	perfluorotoluene (eI)
12	91	1.01	methylcyclopentane
12A	91	1.01	1,2-dichloroethane (traces)
13	92	1.03	tetrahydrofuran
13A	93	1.04	1,1,1-trichloroethane (traces)
13B	96	1.09	benzene
14	97	1.10	carbon tetrachloride
14A	98	1.11	cyclohexane
14B	98	1.11	2-methylhexane
15	100	1.14	3-methylhexane
15A	100	1.14	pentanal (tent)
16	103	1.19	trichloroethylene
16A	103	1.19	C_8H_{18} isomer
17	105	1.21	n-heptane
17A	110	1.30	methylcyclohexane
18	117	1.39	C_8H_{18} isomer
19	119	1.41	toluene
19A	120	1.43	C_8H_{18} isomer
20	122	1.46	C_8H_{18} isomer
21	124	1.49	C_8H_{16} isomer (tent)
21A	125	1.50	$C_6H_{12}O$ isomer (tent)
22	127	1.53	n-octane
23	129	1.56	tetrachloroethylene
24	139	1.70	ethylbenzene
24A	140	1.71	C_9H_{20} isomer
25	141	1.73	xylene isomer
26	145	1.79	styrene
26A	146	1.80	C_9H_{18} isomer
26B	146	1.80	o-xylene
27	148	1.83	n-nonane
27A	151	1.87	C_9H_{18} isomer
27B	152	1.89	isopropylbenzene
28	155	1.93	$C_{10}H_{22}$ isomer
28A	155	1.93	C_9H_{18} isomer
28B	156	1.94	$C_{10}H_{16}$ isomer
28C	158	1.97	n-propylbenzene
29	159	1.99	ethyltoluene isomer
29A	160	2.00	$C_{10}H_{22}$ isomer
30	160	2.00	$C_{11}H_{24}$ isomer
30A	161	2.01	$C_{10}H_{20}$ isomer
30B	161	2.01	$C_{10}H_{22}$ isomer
30C	162	2.03	C_3-alkyl benzene isomer
30D	163	2.04	$C_{10}H_{20}$ isomer
31	165	2.07	C_3-alkyl benzene isomer
31A	165	2.07	$C_{10}H_{20}$ isomer
32	167	2.10	n-decane
32A	168	2.11	unsat. hydrocarbon
33	171	2.16	$C_{11}H_{24}$ isomer
33A	174	2.20	$C_{11}H_{22}$ isomer
33B	176	2.23	C_4-alkyl benzene isomer (traces)
33C	177	2.24	$C_{11}H_{24}$ isomer
33D	180	2.29	C_4-alkyl benzene isomer
34	184	2.34	n-undecane
34A	185	2.36	unsat. hydrocarbon
34B	193	2.47	sat. hydrocarbon
35	240		2,2,4-trimethyl penta-1,3-diol di-isobutyrate (BKG)

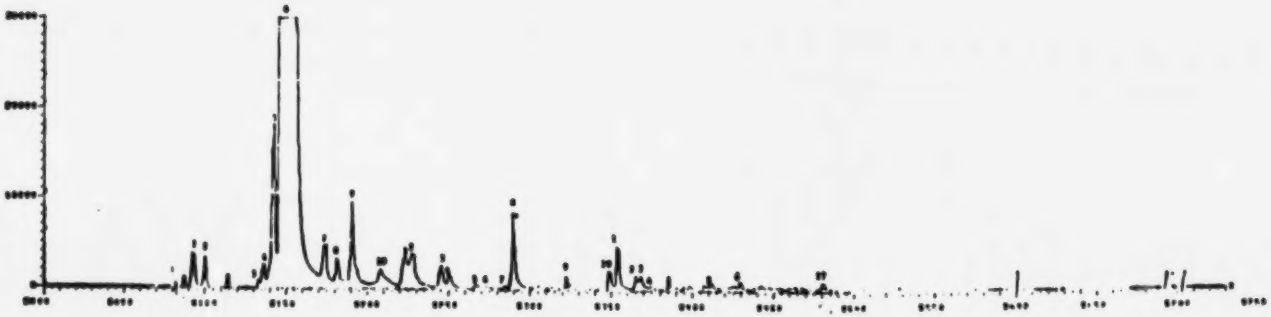

Figure E14. Total ion current plot, IITRI sampler #3, cartridge pair #2, upstream cartridge.

TABLE E14. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #2, IITRI SAMPLER #3

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	52	.46	CO_2
2a	58	.54	C_4H_8 isomer
2b	59	.56	C_4H_{10} isomer
2c	60	.57	acetaldehyde
3	66	.65	isopentane
4a	68	.69	acetone
5	69	.70	*n*-pentane
6	70	.71	methylene chloride
6a	78	.83	cyclopentane
7	79	.84	2-methylpentane
8	82	.89	3-methylpentane
8a	84	.91	hexafluorobenzene (aF)
9	85	.93	*n*-hexane
9a	86	.94	chloroform
9b	88	.97	ethyl acetate (tent.)
9c	90	1.00	perfluorotoluene (aF)
9d	90	1.00	methylcyclopentane
10	91	1.01	tetrahydrofuran
10a	92	1.03	1,1,1-trichloroethane
11	96	1.09	benzene
11a	97	1.10	carbon tetrachloride
12	98	1.11	cyclohexane
12a	99	1.13	2-methylhexane
12b	100	1.14	2,3-dimethylpentane
12c	101	1.16	3-methylhexane
12d	102	1.17	$C_5H_{10}O$ isomer
12e	103	1.19	C_7H_{14} isomer
12f	103	1.19	C_7H_{16} isomer
13	104	1.20	trichloroethylene
14	105	1.21	*n*-heptane
14a	107	1.24	C_7H_{14} isomer
15	111	1.30	methylcyclohexane
16	113	1.33	C_8H_{18} isomer
16a	114	1.34	C_8H_{16} isomer
17	117	1.39	C_8H_{18} isomer
18	119	1.41	toluene
18a	122	1.46	C_8H_{18} isomer
18b	124	1.49	C_8H_{16} isomer
18c	125	1.50	C_8H_{18} isomer
18d	126	1.51	C_8H_{16} isomer
18e	128	1.54	*n*-octane
18f	128	1.54	C_8H_{16} isomer
18g	129	1.56	tetrachloroethylene
19a	134	1.63	C_9H_{20} isomer
19b	135	1.64	C_8H_{16} isomer
19c	136	1.66	C_9H_{20} isomer
19d	137	1.67	C_9H_{18} isomer (tent.)
20	139	1.70	ethylbenzene
21	141	1.73	xylene
21a	142	1.74	C_9H_{20} isomer
21b	144	1.77	C_9H_{20} isomer
22	145	1.79	styrene
23	146	1.80	*o*-xylene
24	148	1.83	*n*-nonane
24a	150	1.86	C_9H_{18} isomer
24b	152	1.89	isopropylbenzene
24c	153	1.90	$C_{10}H_{22}$ isomer
24d	155	1.93	$C_{10}H_{22}$ isomer
24e	155	1.93	propylcyclohexane
24f	156	1.94	$C_{10}H_{16}$ isomer
24g	157	1.96	$C_{10}H_{22}$ isomer
24h	157	1.96	$C_{10}H_{20}$ isomer
24i	158	1.97	*n*-propylbenzene
24j	159	1.99	$C_{10}H_{22}$ isomer
24k	159	1.99	ethyltoluene isomer
24l	160	2.00	$C_{10}H_{22}$ isomer
25	161	2.01	$C_{10}H_{22}$ isomer
25a	163	2.04	*o*-ethyltoluene
25b	163	2.04	$C_{10}H_{22}$ isomer
25c	164	2.06	$C_{10}H_{20}$ isomer
25d	164	2.06	$C_{10}H_{22}$ isomer
25e	166	2.09	1,2,4-trimethylbenzene
25f	166	2.09	$C_{10}H_{20}$ isomer
26	167	2.10	*n*-decane
26a	168	2.11	$C_{10}H_{20}$ isomer
26b	169	2.13	dichlorobenzene isomer
26c	170	2.14	$C_{11}H_{24}$ isomer
26d	171	2.16	$C_{11}H_{24}$ isomer
26e	172	2.17	$C_{11}H_{24}$ isomer
26f	173	2.19	$C_{10}H_{16}$ isomer
26g	174	2.20	$C_{10}H_{20}$ isomer
26h	175	2.21	$C_{11}H_{24}$ isomer
26i	176	2.23	C_4-alkylbenzene isomer
26j	176	2.23	$C_{11}H_{22}$ isomer
26k	177	2.24	C_4-alkylbenzene isomer
26l	177	2.24	$C_{11}H_{24}$ isomer
26m	178	2.26	$C_{11}H_{22}$ isomer
26n	178	2.26	$C_{11}H_{24}$ isomer
26o	179	2.27	$C_{11}H_{24}$ isomer
26p	180	2.29	C_4-alkylbenzene isomer
26q	181	2.30	$C_{11}H_{22}$ isomer
26r	181	2.30	C_4-alkylbenzene isomer

TABLE E14 (CONT'D)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound	Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
26s	182	2.31	$C_{11}H_{22}$ isomer				
26t	183	2.33	$C_{11}H_{22}$ isomer (tent.)				
27	184	2.34	*n*-undecane				
27a	186	2.37	$C_{11}H_{22}$ isomer				
27b	187	2.39	$C_{12}H_{26}$ isomer				
27c	188	2.40	C_4-alkylbenzene isomer				
27d	189	2.41	$C_{11}H_{20}$ isomer				
27e	190	2.43	$C_{12}H_{26}$ isomer				
27f	190	2.43	$C_{11}H_{20}$ isomer				
27g	191	2.44	$C_{12}H_{26}$ isomer				
27h	194	2.49	$C_{12}H_{24}$ isomer				
27i	194	2.49	C_5-alkylbenzene isomer				
27j	195	2.50	$C_{12}H_{26}$ isomer				
27k	199	2.56	naphthalene				
27l	200	2.57	*n*-dodecane				

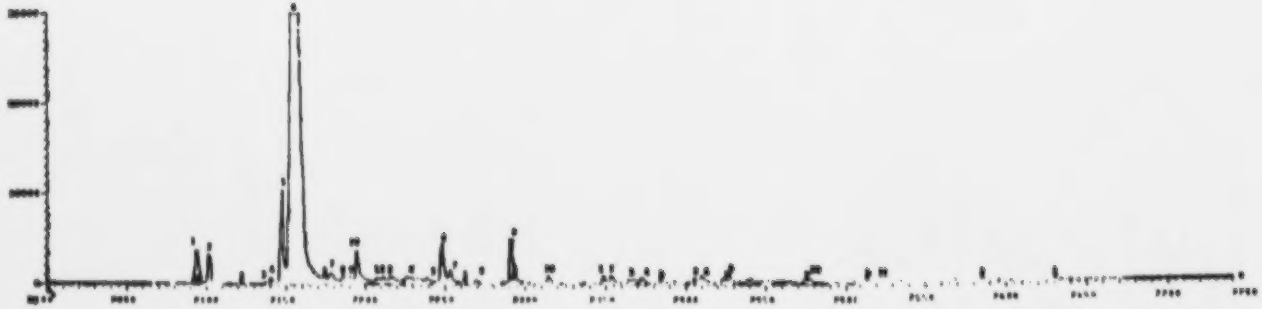

Figure E15. Total ion current plot, IITRI sampler #3, cartridge pair #3, upstream cartridge.

TABLE E15. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #3, IITRI SAMPLER #3

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	52	.45	CO_2
2a	59	.55	C_4H_8 isomer
2b	60	.56	C_4H_{10} isomer
2c	61	.58	acetaldehyde
3	67	.66	isopentane
4a	69	.69	propanal
5	70	.70	*n*-pentane
5a	71	.72	acetone
6	72	.73	methylene chloride
6a	80	.85	cyclopentane
7	81	.86	2-methylpentane
8	84	.90	3-methylpentane
9	85	.92	hexafluorobenzene (eS)
10	86	.93	*n*-hexane
10a	87	.94	chloroform
10b	88	.96	2-butanone
11	91	1.00	perfluorotoluene (eS)
12	92	1.01	methylcyclopentane
12a	93	1.03	1,2-dichloroethane
13	94	1.04	tetrahydrofuran and 1,1,1-trichloroethane (traces)
14	98	1.10	benzene
14a	99	1.11	carbon tetrachloride
14b	100	1.13	cyclohexane
14c	101	1.14	2-methylhexane
14d	101	1.14	2,3-dimethylpentane
15	102	1.15	3-methylhexane
15a	103	1.17	$C_5H_{10}O$ and C_7H_{14} isomers
16	104	1.18	trichloroethylene
17	106	1.21	*n*-heptane
17a	110	1.27	C_7H_{14} isomer
18	112	1.30	methylcyclohexane
18a	113	1.31	C_8H_{18} isomer
18b	114	1.32	C_7H_{14} isomer
18c	115	1.34	4-methyl-2-pentanone
18d	117	1.37	C_8H_{18} isomer
19	119	1.39	toluene
19a	121	1.42	C_8H_{18} isomer
19b	122	1.44	C_8H_{18} isomer
19c	124	1.46	C_8H_{16} isomer
19d	125	1.48	C_8H_{18} isomer
19e	126	1.49	C_8H_{16} isomer
20	128	1.52	*n*-octane
20a	130	1.55	tetrachloroethylene
20b	134	1.61	C_9H_{20} isomer
20c	136	1.63	chlorobenzene
21	139	1.68	ethylbenzene
21a	140	1.69	C_9H_{20} isomer
22	141	1.70	xylene isomer
22a	142	1.72	C_9H_{20} isomer
23	144	1.75	styrene
23a	145	1.76	*o*-xylene
23b	146	1.77	C_9H_{18} isomer
24	147	1.79	*n*-nonane
24a	149	1.82	C_9H_{18} isomer
24b	150	1.83	$C_{10}H_{22}$ isomer
24c	151	1.85	isopropylbenzene
24d	152	1.86	$C_{10}H_{22}$ isomer
24e	152	1.86	C_9H_{18} isomer
24f	154	1.89	propylcyclohexane
24g	155	1.90	$C_{10}H_{16}$ isomer
24h	155	1.90	$C_{10}H_{22}$ isomer
24i	156	1.92	$C_{10}H_{20}$ isomer (tent.)
24k	157	1.93	$C_{10}H_{22}$ isomer
25	158	1.94	ethyltoluene isomer
26	160	1.97	$C_{10}H_{22}$ isomer
26a	161	1.99	$C_{10}H_{20}$ isomer
26b	161	1.99	$C_{10}H_{22}$ isomer
26c	162	2.00	*o*-ethyltoluene
26d	164	2.03	$C_{10}H_{20}$ isomer
27	165	2.04	1,2,4-trimethylbenzene
28	166	2.06	*n*-decane
28a	168	2.37	$C_{10}H_{20}$ and dichlorobenzene isomers
28b	169	2.10	C_4-alkyl benzene isomer
28c	170	2.11	1,2,3-trimethylbenzene and $C_{11}H_{24}$ isomer
28d	172	2.14	$C_{11}H_{22}$ isomer
28e	173	2.15	butylcyclohexane
28f	174	2.17	$C_{11}H_{24}$ isomer
28g	175	2.18	C_4-alkyl benzene isomer
28h	176	2.20	C_4-alkyl benzene isomer
28i	177	2.21	$C_{11}H_{24}$ isomer
28j	178	2.23	$C_{11}H_{24}$ isomer
28k	178	2.23	C_4-alkyl benzene isomer
28l	179	2.24	acetophenone
28m	179	2.24	C_4-alkyl benzene isomer
28n	181	2.27	C_4-alkyl benzene and $C_{11}H_{22}$ isomers
29	182	2.28	$C_{11}H_{22}$ isomer (tent.)
30	183	2.30	*n*-undecane
30a	183	2.32	$C_{11}H_{20}$ isomer

TABLE E15 (CONT'D)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
30b	186	2.34	C_4-alkyl benzene and $C_{12}H_{26}$ isomers
30c	187	2.35	C_4-alkyl benzene isomer
30d	188	2.37	$C_{11}H_{20}$ isomer
30e	189	2.38	C_5-alkyl benzene isomer
30f	193	2.44	C_5-alkyl benzene isomer
30g	195	2.46	C_5-alkyl benzene and $C_{12}H_{26}$ isomers
30h	198	2.51	naphthalene
31	198	2.51	*n*-dodecane
31a	201	2.55	$C_{13}H_{28}$ isomer
31b	205	2.61	$C_{12}H_{24}$ isomer
31c	209	2.66	$C_{13}H_{28}$ isomer
31d	211	2.69	C_6-alkyl benzene isomer
31e	212	2.70	*n*-tridecane
31f	225	2.89	fluor compound unknown
31g	226	2.90	*n*-tetradecane

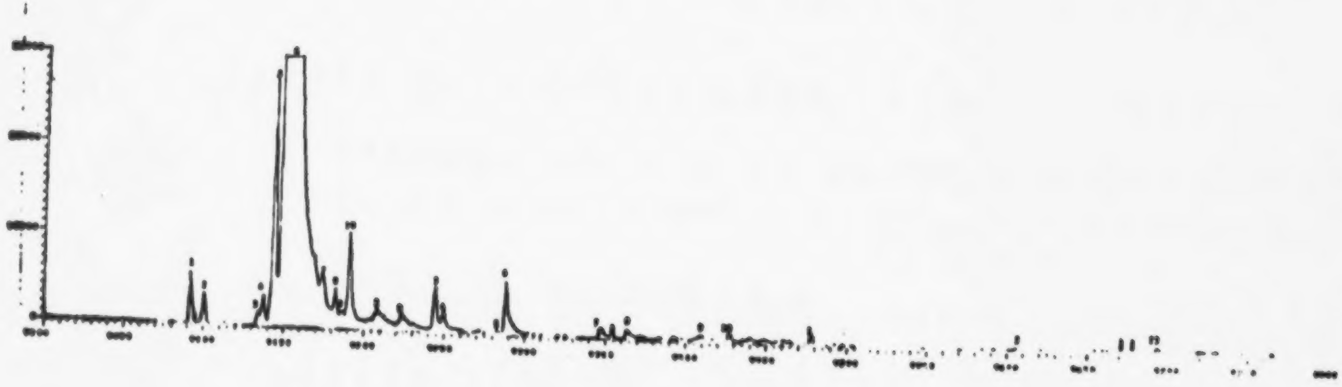

Figure E16. Total ion current plot, IITRI sampler #3, cartridge pair #4, upstream cartridge (blank).

TABLE E16. COMPOUNDS IDENTIFIED IN UPSTREAM CARTRIDGE, CARTRIDGE PAIR #4, IITRI SAMPLER #3 (BLANK)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	51	.45	CO_2
2A	56	.52	C_4H_{10} isomer
2B	58	.55	C_4H_{10} isomer
2C	60	.58	acetaldehyde
3	66	.67	isopentane
5	69	.71	n-pentane
5A	70	.72	acetone
6	70	.72	methylene chloride
6A	79	.86	cyclopentane
7	79	.86	2-methylpentane
8	82	.90	3-methylpentane
9	84	.93	hexafluorobenzene (sI)
10	85	.94	n-hexane
10A	86	.96	chloroform
10B	88	.99	ethyl acetate (tent.)
10C	89	1.00	perfluorotoluene (sI)
10D	90	1.01	methylcyclopentane
11	91	1.03	tetrahydrofuran and 1,2-dichloroethane (traces)
11A	92	1.04	1,1,1-trichloroethane
11B	93	1.06	C_6H_{12} isomer
11C	95	1.09	benzene
12	96	1.10	carbon tetrachloride
12A	97	1.12	cyclohexane
12B	102	1.19	C_7H_{16} isomer
13	103	1.20	trichloroethylene
14	105	1.23	n-heptane
14A	111	1.32	methylcyclohexane
14B	113	1.35	C_8H_{18} isomer
14C	114	1.36	$C_6H_{12}O$ isomer
15	116	1.39	C_8H_{18} isomer
16	118	1.42	toluene
16A	123	1.49	C_8H_{18} isomer
16B	126	1.54	C_8H_{18} isomer
16C	128	1.57	tetrachloroethylene
17	139	1.72	ethylbenzene
17A	142	1.77	xylene isomer
17B	144	1.80	C_9H_{20} isomer
18	144	1.80	styrene
18A	146	1.83	n-nonane
18B	147	1.84	C_9H_{18} isomer (tent.)
18C	150	1.88	$C_{10}H_{22}$ isomer
18D	150	1.88	isopropylbenzene
18E	151	1.90	$C_{10}H_{22}$ isomer
18F	152	1.91	$C_{10}H_{22}$ isomer
18G	154	1.94	$C_{10}H_{22}$ isomer
18H	154	1.94	propylcyclohexane
18I	155	1.96	$C_{10}H_{22}$ isomer
18J	156	1.97	$C_{10}H_{20}$ isomer
18K	157	1.99	n-propylbenzene
18L	158	2.00	ethyltoluene isomer
19	160	2.03	$C_{10}H_{22}$ isomer
19A	161	2.04	$C_{10}H_{20}$ isomer
19B	162	2.06	$C_{10}H_{22}$ isomer
19C	164	2.09	$C_{10}H_{20}$ isomer
19D	165	2.10	$C_{10}H_{20}$ isomer
19E	166	2.12	1,2,4-trimethylbenzene
19F	166	2.12	$C_{10}H_{20}$ isomer
20	166	2.12	n-decane
20A	168	2.14	$C_{10}H_{20}$ isomer
20B	169	2.16	dichlorobenzene
20C	170	2.17	$C_{11}H_{24}$ isomer
20D	171	2.19	$C_{11}H_{24}$ isomer
20E	172	2.20	$C_{11}H_{24}$ isomer
20F	174	2.23	$C_{10}H_{20}$ and $C_{11}H_{22}$ isomers
20G	175	2.25	$C_{11}H_{22}$ isomer
20H	175	2.25	$C_{11}H_{24}$ isomer
20I	176	2.26	$C_{11}H_{22}$ isomer (tent.)
20J	177	2.28	$C_{11}H_{24}$ isomer
20K	179	2.30	$C_{11}H_{22}$ isomer (tent.)
20L	180	2.32	C_4-alkyl benzene isomer
20M	180	2.33	$C_{11}H_{24}$ isomer
20N	182	2.35	$C_{11}H_{22}$ isomer
21	183	2.36	n-undecane
21A	184	2.38	$C_{11}H_{22}$ isomer
21B	187	2.42	$C_{11}H_{22}$ isomer
21C	188	2.43	$C_{12}H_{26}$ isomer
21D	190	2.46	C_5-alkyl cyclohexane isomer
21E	191	2.48	$C_{11}H_{20}$ isomer
21F	192	2.49	$C_{12}H_{26}$ isomer
21G	195	2.54	$C_{12}H_{26}$ isomer
21H	198	2.58	naphthalene
21I	199	2.59	n-dodecane
22	227	3.00	chloro-fluor cmpd. unknown
23	240	3.42	sat. hydrocarbon

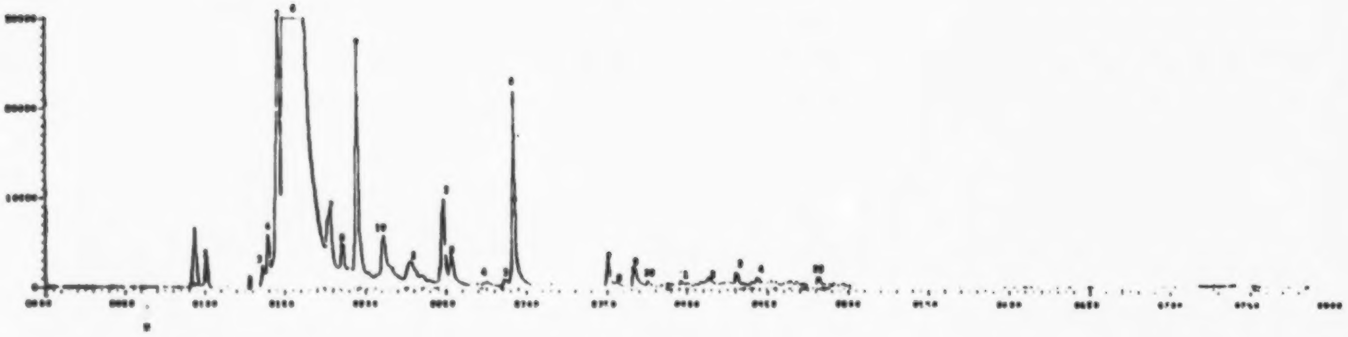

Figure E17. Total ion current plot, IITRI sampler #3, cartridge pair #4, downstream cartridge (blank).

TABLE E17. COMPOUNDS IDENTIFIED IN DOWNSTREAM CARTRIDGE, CARTRIDGE PAIR #4, IITRI SAMPLER #3 (BLANK)

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	52	.46	CO_2
2a	57	.53	C_4H_{10} isomer
2b	59	.56	C_4H_8 isomer
2c	59	.56	C_4H_{10} isomer
2d	60	.57	acetaldehyde
3	66	.66	isopentane
4a	68	.69	acetone
5	68	.69	n-pentane
6	69	.70	methylene chloride
6a	79	.84	cyclopentane
7	80	.86	2-methylpentane
8	82	.89	3-methylpentane
8a	84	.91	hexafluorobenzene (aF)
9	85	.93	n-hexane
9a	86	.94	chloroform
9b	88	.97	ethyl acetate (tent.)
9c	90	1.00	perfluorotoluene (aF)
10	91	1.01	tetrahydrofuran
10a	93	1.04	1,1,1-trichloroethane
10b	96	1.09	benzene
11	97	1.10	carbon tetrachloride
11a	98	1.11	cyclohexane
11b	99	1.13	2,3-dimethylpentane
12	103	1.19	trichloroethylene
13	106	1.23	n-heptane
13a	112	1.31	C_7H_{14} isomer
14	114	1.34	C_8H_{18} isomer
15	118	1.40	C_8H_{18} isomer
16	119	1.41	toluene
16a	124	1.49	C_8H_{18} isomer
16b	127	1.53	n-octane
16c	128	1.54	tetrachloroethylene
17	139	1.70	ethylbenzene
18	142	1.74	xylene isomer
18a	143	1.76	C_9H_{20} isomer
18b	144	1.77	C_9H_{20} isomer
19	145	1.79	styrene
19a	148	1.83	C_9H_{18} isomer
20	148	1.83	n-nonane
20a	151	1.87	C_9H_{18} isomer
20b	152	1.89	$C_{10}H_{22}$ isomer
20c	153	1.90	isopropylbenzene
20d	154	1.91	$C_{10}H_{22}$ isomer
21	155	1.93	$C_{10}H_{22}$ isomer
21a	155	1.93	propylcyclohexane
21b	157	1.96	$C_{10}H_{22}$ isomer
21c	157	1.96	$C_{10}H_{20}$ isomer
21d	158	1.97	n-propylbenzene
21e	159	1.99	$C_{10}H_{22}$ isomer
21f	160	2.00	ethyltoluene isomer
21g	160	2.00	$C_{10}H_{22}$ isomer
22	161	2.01	$C_{10}H_{22}$ isomer
22a	163	2.04	$C_{10}H_{22}$ isomer
22b	164	2.06	$C_{10}H_{20}$ isomer
22c	165	2.07	$C_{10}H_{20}$ isomer
23	166	2.09	n-decane
23a	168	2.11	$C_{10}H_{20}$ isomer
23b	170	2.14	$C_{11}H_{24}$ isomer
24	171	2.16	$C_{11}H_{24}$ isomer
24a	172	2.17	$C_{11}H_{24}$ isomer
24b	173	2.19	$C_{10}H_{20}$ isomer
24c	174	2.20	$C_{11}H_{22}$ and butylcyclohexane
-	-	-	isomers
24d	176	2.23	$C_{11}H_{24}$ isomer
24e	177	2.24	$C_{11}H_{22}$ isomer
24f	178	2.26	$C_{11}H_{24}$ isomer
24g	182	2.31	$C_{11}H_{22}$ isomer
25	185	2.36	n-undecane
25a	186	2.37	$C_{11}H_{22}$ isomer
25b	188	2.40	$C_{12}H_{26}$ isomer
25c	193	2.47	$C_{11}H_{20}$ isomer
25d	195	2.50	$C_{12}H_{24}$ isomer
25e	200	2.57	naphthalene (traces)

APPENDIX F

ORGANICS IDENTIFIED FROM HI-VOL FILTERS FROM IITRI COLLECTION SYSTEM

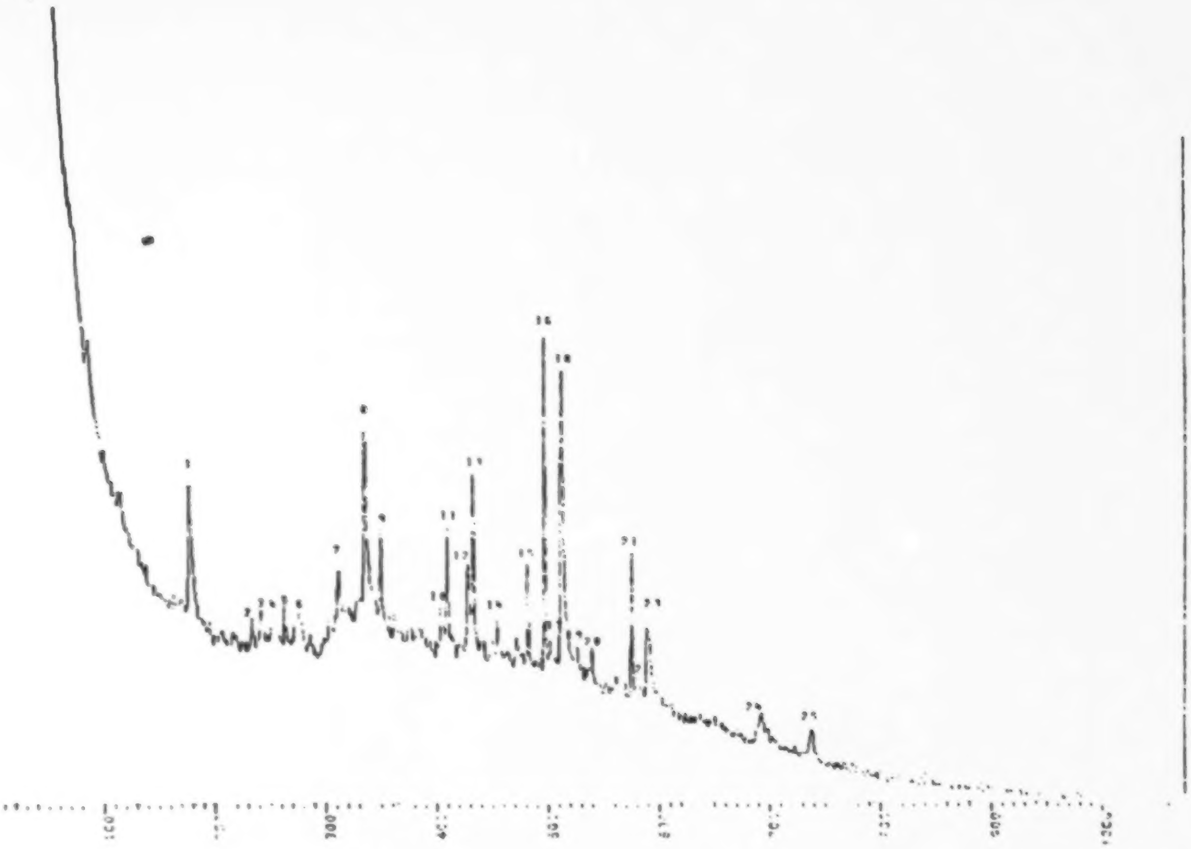

Figure F1. TIC-Acid fraction from Hi-Vol filter extract, filter #0089.

TABLE F1. COMPOUNDS IDENTIFIED FROM ACID FRACTION, HI-VOL FILTER #0089

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	129	.759	phthalic anhydride
2	144	1.000	d_5-phenol (int. std.)
3	146	1.039	$C_7H_{12}O_2$ isomer (tent.)
4	148	1.078	benzofuran (tent.)
5	151	1.129	dimethyl phthalate
6	154	1.190	sat'd hydrocarbon
7	164	1.345	unknown
8	170	1.440	diethyl phthalate
9	174	1.504	2,2,4-trimethylpenta-1,3-diol di-isobutyrate (bkg)
10	188	1.737	trimethylphenyl-indane isomer
11	189	1.763	$C_{15}H_{30}O_2$ isomer (methyl tetradecanoate)
12	194	1.845	sat'd hydrocarbon
13	195	1.862	siloxane
14	200	1.957	methyl pentadecanoate
15	207	2.073	siloxane (column bleed)
16	212	2.138	$C_{17}H_{34}O_2$ isomer (methyl palmitate, methyl, methyl hexadecanoate)
17	213	2.159	phthalate
18	216	2.203	heptadecanol isomer
19	219	2.250	heptadecanol isomer
20	223	2.323	unknown
21	232	2.478	methyl octadecanoate
22	233	2.508	sat'd hydrocarbon
23	236	2.539	stearic acid (tent.)
24	262	2.983	$C_{19}H_{40}O_2$ isomer
25	265	3.181	

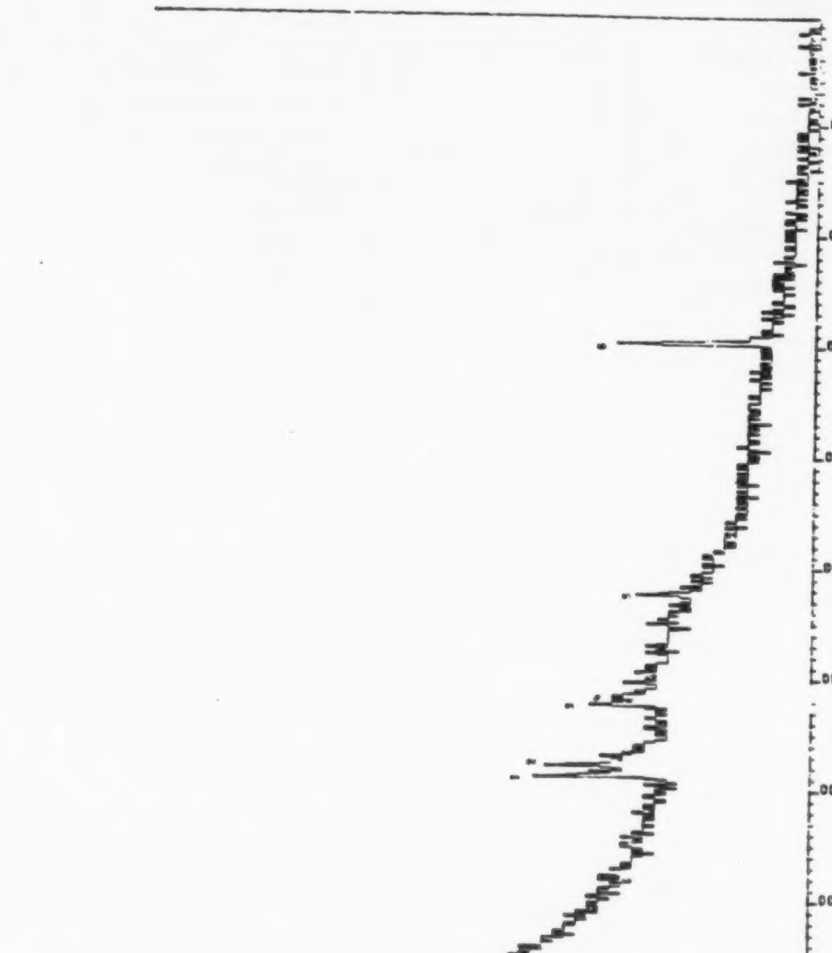

Figure F2. TIC-Base fraction from Hi-Vol filter extract, filter #0089.

TABLE F2. COMPOUNDS IDENTIFIED FROM BASE FRACTION, HI-VOL FILTER #0089

Chromatographic Peak No.	Elution Temp. (°C)	Compound
1	162	diethyl phthalate
2	164	2,2,4-trimethylpenta-1,3-diol diisobutyrate (bkg)
3	174	1,1,3-trimethyl-3-phenyl indane
4	176	unknown
5	208	phthalate
6	265	dioctyl phthalate isomer

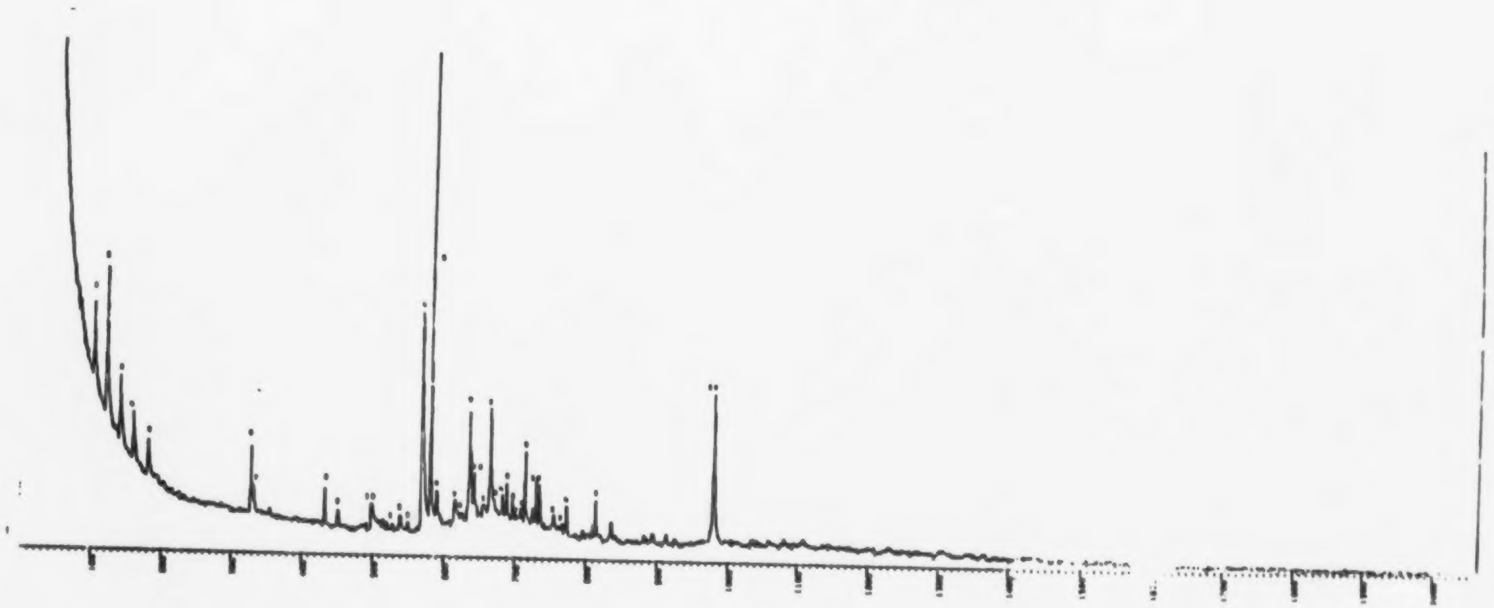

Figure F3 . TIC - NPN fraction from Hi-Vol filter extract, filter #0089.

TABLE F3. COMPOUNDS IDENTIFIED FROM NPN FRACTION, HI-VOL FILTER #0089

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	110	.153	unknown
2	113	.180	unknown
3	120	.210	saturated hydrocarbon
4	124	.239	unknown
5	130	.270	octamethyl cyclotetrasiloxane
6	168	.491	hexamethyl cyclotrisiloxane
7	169	.495	decamethyl cyclopentasiloxane
8	195	.649	siloxane (tent.)
9	203	.676	unknown
10	212	.748	dimethyl phthalate isomer
11	220	.791	siloxane (tentative)
12	225	.808	$C_{15}H_{32}$ isomer
13	228	.824	background
14	231	.851	diethyl phthalate
15	233	.872	2,2,4-trimethyl-1,3-pentadiol diisobutyrate (bkg)
16	235	.884	$C_{16}H_{34}$ isomer
17	241	.923	$C_{14}H_{28}$ isomer (tentative)
18	244	.937	$C_{14}H_{30}$ isomer
19	248	.953	1,1,3-trimethyl-3-phenyl indane
20	249	.962	dodecoxyethanol (tent)
21	252	.989	$C_{16}H_{32}$ isomer
22	254	.997	siloxane (tentative)
23	257	1.000	d_{10}-anthracene (int. std)
24	259	1.024	$C_{18}H_{38}$ isomer
25	261	1.033	$C_{21}H_{44}$ isomer
26	262	1.045	diethyl phthalate
27	264	1.054	unknown
28	265	1.062	dodecoxyethanol (tent.)
29	265	1.072	unknown
30	265	1.095	$C_{17}H_{34}O_2$ isomer
31	265	1.102	butyl phthalate isomer
32	265	1.132	unknown
33	265	1.150	saturated hydrocarbon
34	265	1.159	unknown
35	265	1.221	siloxane (tentative)
36	265	1.470	octyl phthalate isomer

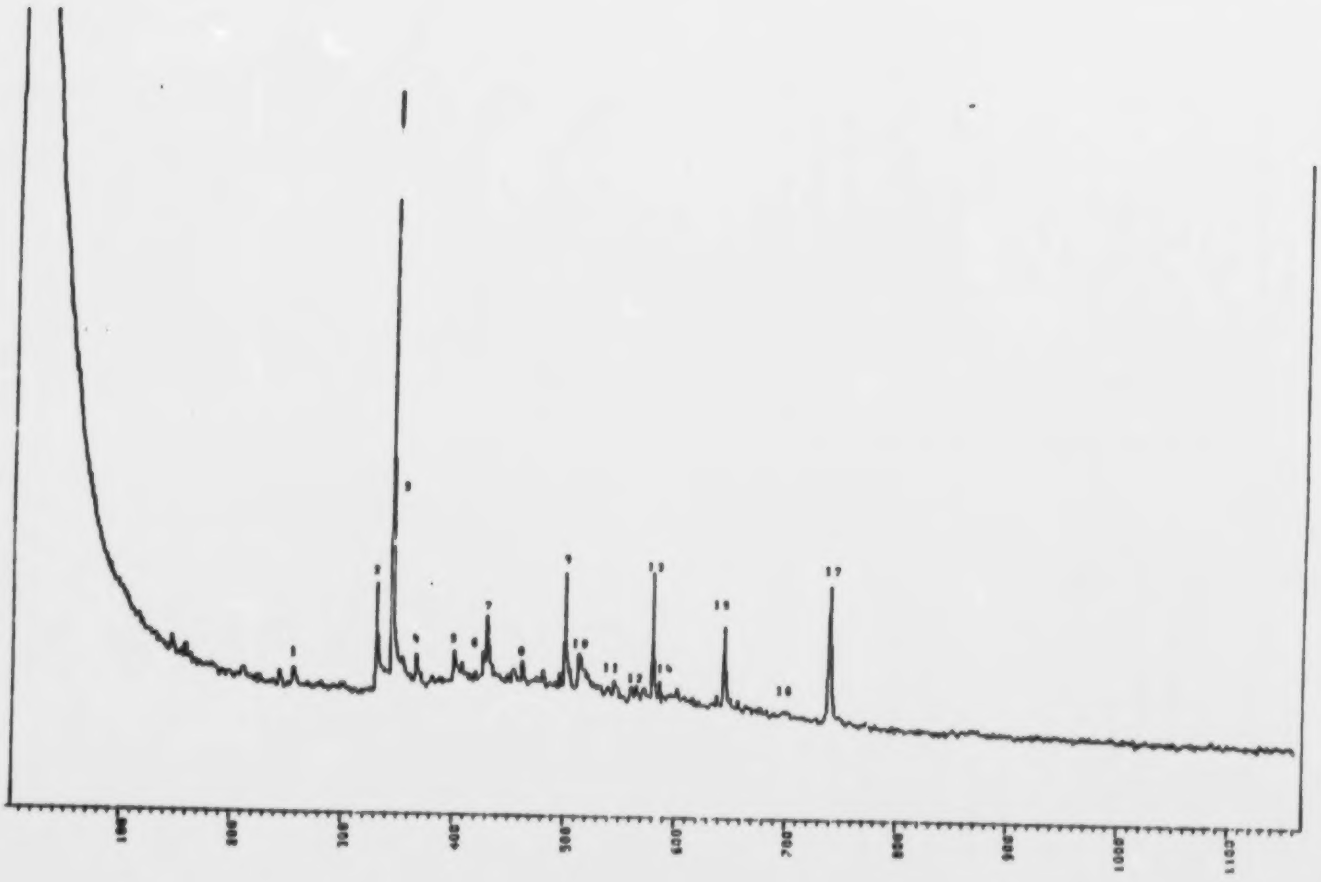

Figure F4. TIC-PNA fraction from Hi-Vol filter #0089.

TABLE F4. COMPOUNDS IDENTIFIED FROM PNA FRACTIONS, HI-VOL FILTER #0089

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	150	0.594	dimethyl phthalate
2	168	.769	diethyl phthalate
3	172	.800	2,2,4-trimethylpenta-1,3-diol diisobutyrate (bkg)
4	179	.853	tributyl phosphate
5	187	.932	1,1,3-trimethyl-3-phenyl indane
6	194	.993	anthracene
7	195	1.000	d_{10}-anthracene (int. std)
8	203	1.075	alkyl phthalate
9	213	1.166	dibutyl phthalate
10	216	1.194	palmitic acid (tent.)
11	225	1.270	$C_{16}H_{10}$ isomer (fluoranthene)
12	229	1.315	$C_{16}H_{10}$ isomer (pyrene)
13	234	1.350	$C_{18}H_{34}O_4$ isomer (tent.)
14	235	1.364	$C_{18}H_{34}O_4$ isomer (tent.)
15	250	1.501	butyl benzyl phthalate
16	264	1.627	$C_{18}H_{12}$ isomer (chyrsene)
17	265	1.723	dioctyl phthalate isomer

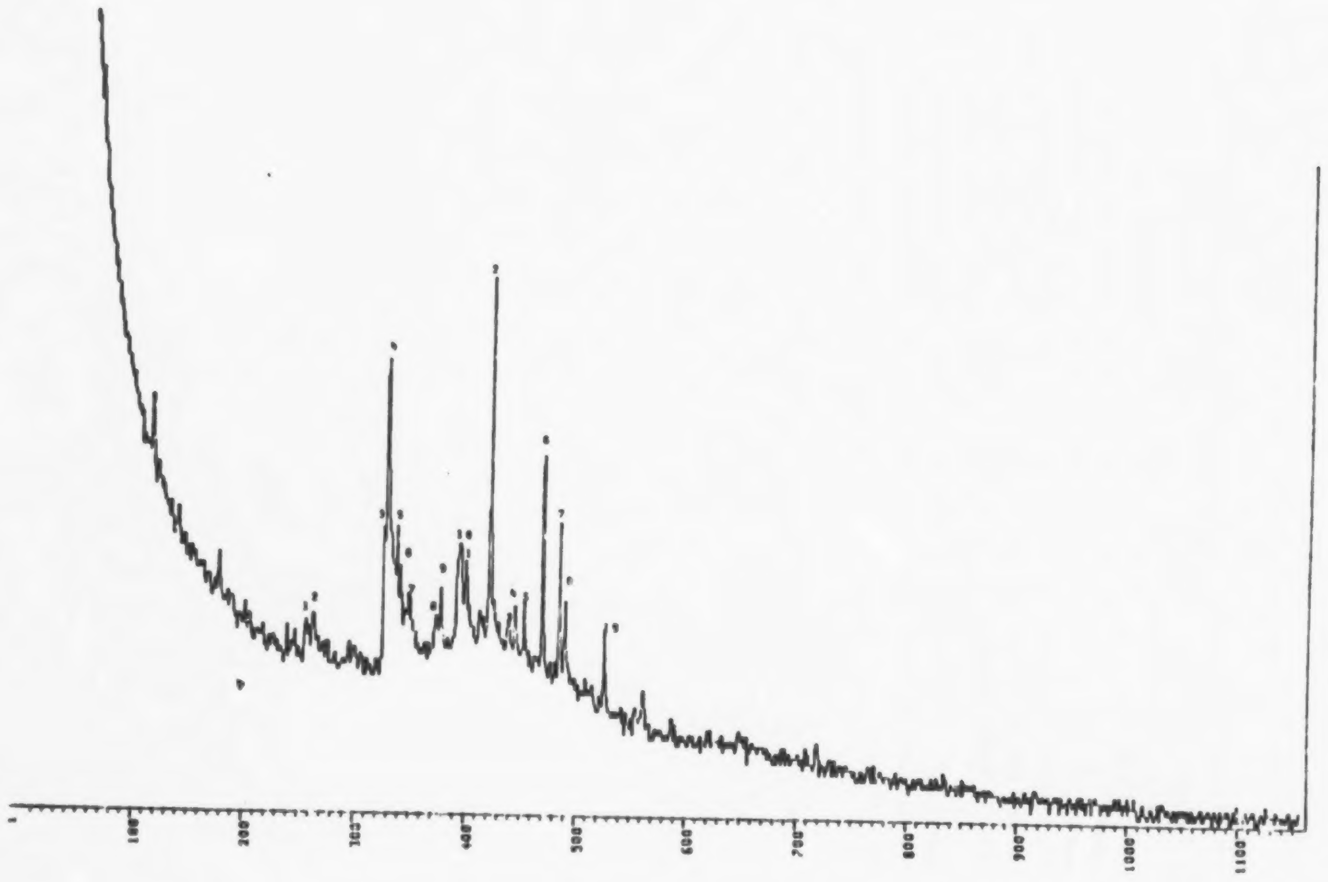

Figure F5. TIC-PN fraction from Hi-Vol filter extract, filter #0089.

TABLE F5. COMPOUNDS IDENTIFIED FROM PN FRACTION, HI-VOL FILTER #0089

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	174	.597	phthalate
2	176	.611	dimethyl phthalate
3	192	.758	phthalate
4	193	.762	diethyl phthalate
5	195	.779	phthalate
6	196	.795	saturated hydrocarbon
7	198	.809	saturated hydrocarbon
8	205	.865	saturated hydrocarbon
9	206	.876	saturated hydrocarbon
10	210	.916	trimethyl-phenyl-indane isomer
11	211	.928	background
12	217	.981	siloxane
13	219	1.000	d_{10}-anthracene (int. std.)
14	223	1.037	saturated hydrocarbon
15	225	1.049	saturated hydrocarbon
16	230	1.091	siloxane
17	233	1.128	methyl palmitate
18	235	1.140	phthalate
19	244	1.224	siloxane

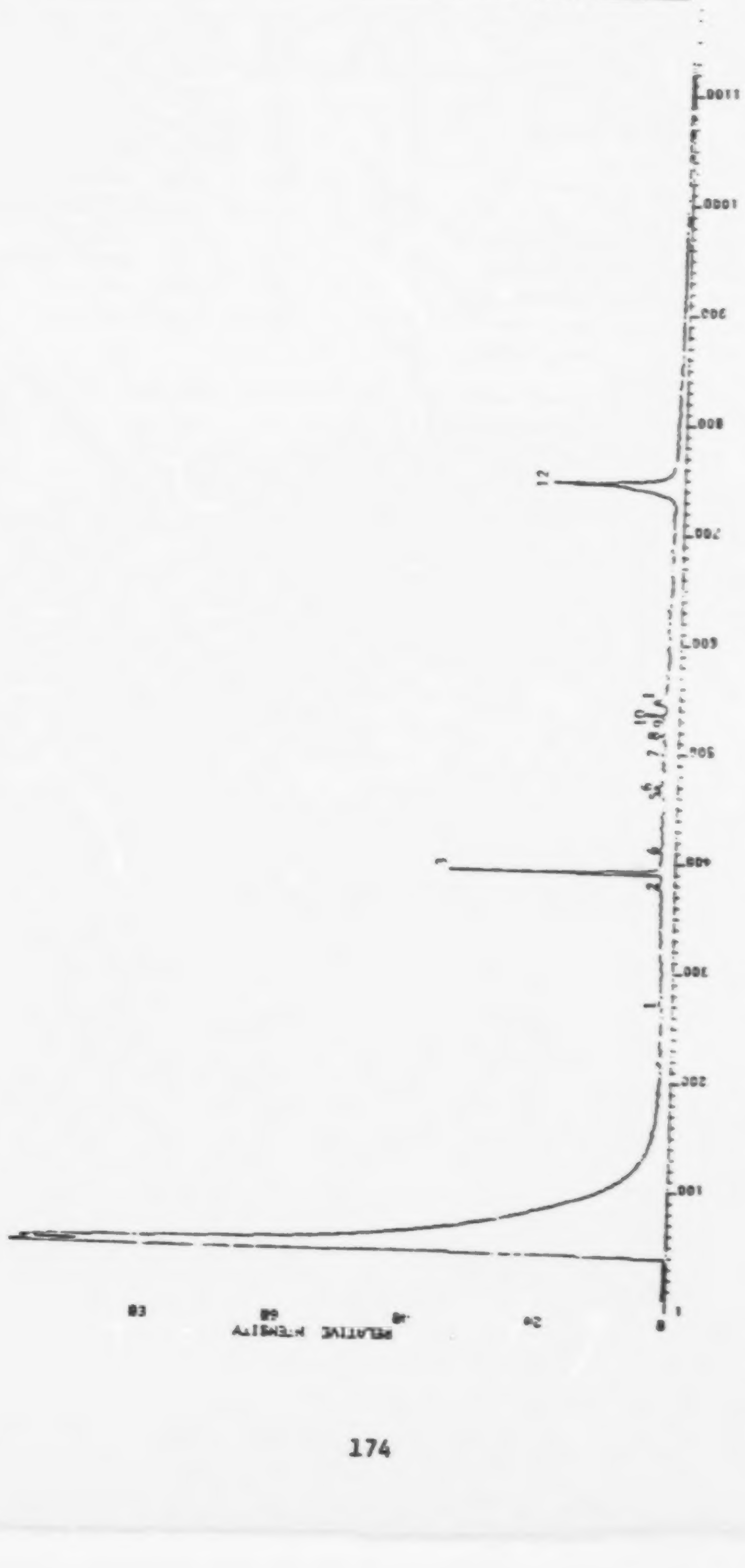

Figure F6. TIC - from Hi-Vol filter extract filter No. 90.

TABLE F6. COMPOUNDS IDENTIFIED FROM HI-VOL FILTER #90

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	146°	.582	siloxane
2	170°	.807	phthalate
3	173°	.835	2,2,4-trimethylpenta-1, 3-diol di-isobutyrate (BKG)
4	178°	.880	tri-butyl phosphate
5	191°	1.000	d_{10} anthracene (int. std.)
6	191°	1.006	siloxane
7	198°	1.066	phthalate
8	202°	1.117	siloxane
9	206°	1.139	methyl palmitate
10	206°	1.143	phthalate
11	209°	1.173	sat. hydrocarbon
12	234°	1.161	di-*n*-octyl phthalate

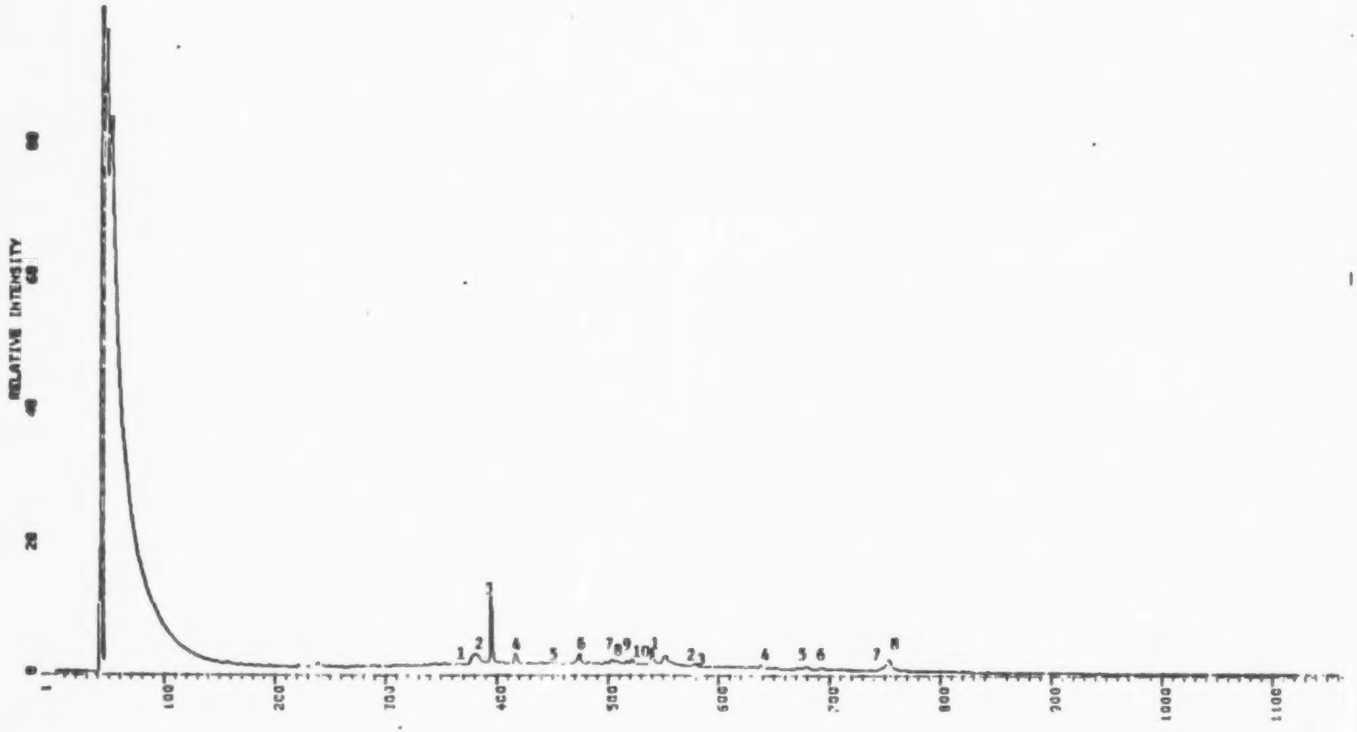

Figure F7. TIC - from Hi-Vol filter extract, filter No. 104.

TABLE F7. COMPOUNDS IDENTIFIED FROM HI-VOL FILTER #104

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	167°	.773	siloxane (tent)
2	171°	.803	xylyl butanoic acid and phthalate (tent)
3	174°	.837	2,2,4-trimethyl penta-1,3-diol di-isobutyrate (BKG)
4	179°	.881	tributyl phosphate
5	186°	.947	siloxane
6a	192°	1.000	d_{10}-anthracene (int. std.)
6	192°	1.004	siloxane
7	199°	1.066	phthalate
8	200°	1.074	unknown
9	202°	1.093	siloxane
10	203°	1.104	unknown
11	207°	1.138	methyl palmatate
11b	207°	1.140	phthalate
12	216°	1.222	unknown
13	216°	1.227	siloxane
14	230°	1.352	siloxane
15	239°	1.439	phthalate
16	242°	1.464	siloxane
17	254°	1.576	siloxane
18	256°	1.595	phthalate

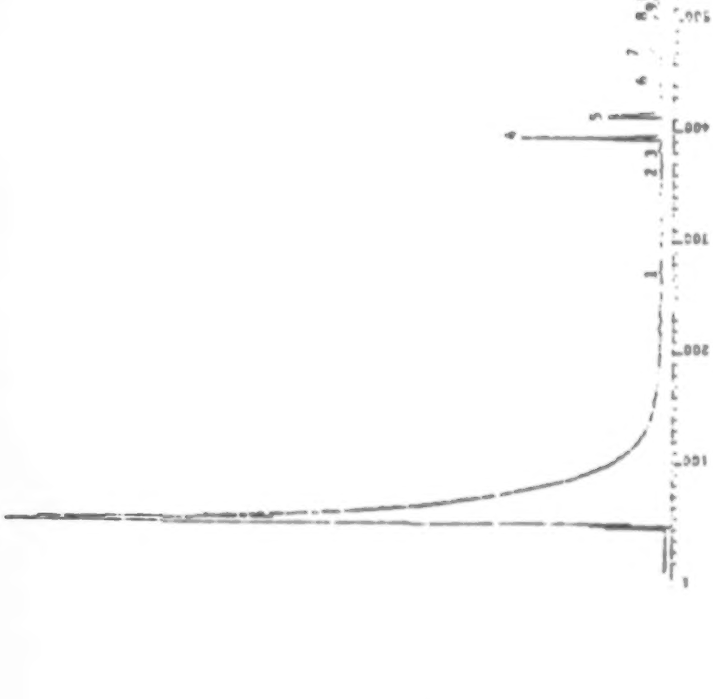

Figure F8. TIC-from Hi-Vol filter extract, filter #109.

TABLE F8. COMPOUNDS IDENTIFIED FROM HI-VOL FILTER #109

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	146°	.577	siloxane
2	167°	.770	siloxane (tent)
3	171°	.805	phthalate and alkyl benzene
4	174°	.831	2,2,4-trimethyl-1,5,pentadiol dl-isobutyrate (BKC)
5	178°	.871	unknown
6	186°	.941	siloxane
7	192°	1.000	unknown (siloxane) and d_{10}-anthracene (int. std.)
8	199°	1.061	phthalate
9	202°	1.089	siloxane
10	203°	1.099	unknown
11	207°	1.137	phthalate
12	210°	1.167	unknown
13	215°	1.216	unknown
13b	216°	1.222	siloxane (tent)
14	229°	1.342	siloxane
15	244°	1.452	siloxane
16	255°	1.577	dl-N-octyl-phthalate

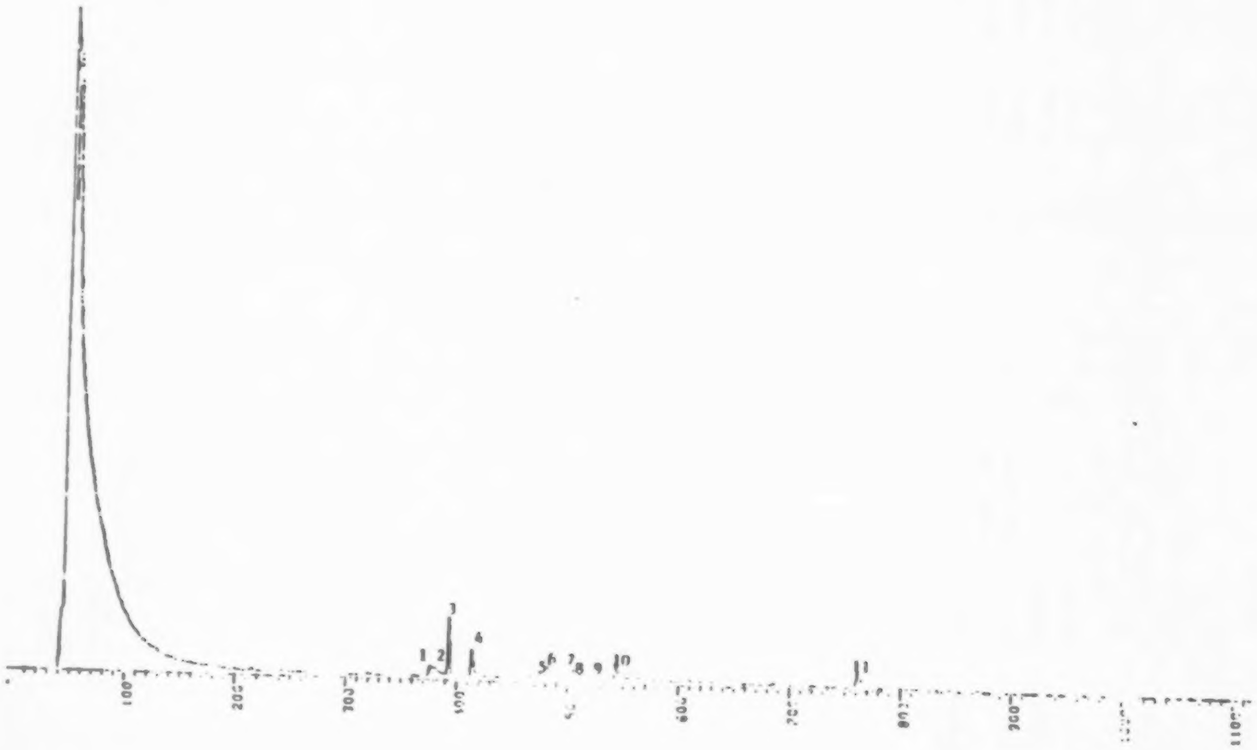

Figure F9. TIC-from Hi-Vol filter extract, filter #113.

TABLE F9. COMPOUNDS IDENTIFIED FROM HI-VOL FILTER #113

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	170°	.789	xylyl butanoic acid isomer (tent)
2	171°	.800	phthalate
3	174°	.825	2,2,4-trimethylpenta-1, 3-diol di-isobutyrate (BKC)
4	178°	.867	tri-butyl phosphate
5	193°	1.000	d_{10}-anthracene (int. std.)
5a			siloxane
6	194°	1.015	siloxane
7	199°	1.061	di-isobutyl phthalate
8	201°	1.074	(p-tert-butylphenoxy) ethanol isomer (tent)
9	204°	1.103	siloxane
10	208°	1.143	phthalate
11	258°	1.602	di-n-octyl phtlalate

APPENDIX G

ORGANICS IDENTIFIED FROM DICHOTOMOUS FILTERS

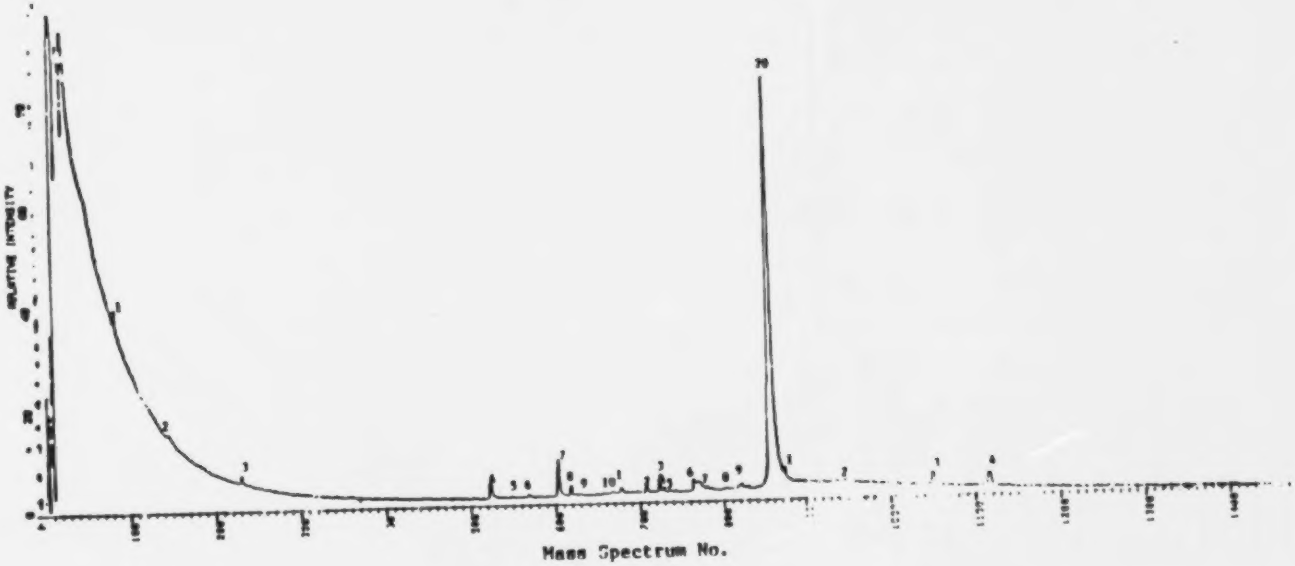

Figure G1. Total ion current chromatogram of extract from dichotomous filter No. 4F-011.

TABLE G1. COMPOUNDS TENTATIVELY IDENTIFIED FROM DICHOTOMOUS SAMPLE #4F-011

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound	Chromato-grahpic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	67	.117	hexamethylcyclotrisiloxane	12	209	1.000	d_{10}-anthracene (int. std.)
2	88	.204	satd. hydrocarbon (tent)	13	213	1.204	$C_{18}H_{36}$ isomer
3	100	.325	octamethylcyclotetrasiloxane	14	214	1.028	n-octadecane
3A	102	.337	satd. hydrocarbon (traces)	15	216	1.040	unsatd. hydrocarbon (tent)
4	167	.740	dimethyl phthalate (background)	16	223	1.079	unknown
5	173	.788	satd. hydrocarbon	17	226	1.109	dibutyl-phthalate
6	177	.803	C_9-alkyl phenol isomer	18	227	1.122	satd. hydrocarbon
7	186	.853	diethyl phthalate (background)	19	235	1.151	satd. hydrocarbon
8	189	.874	2,2,4-trimethyl penta,1-3-diol di-isobutyrate (BKG)	20	244	1.215	$C_{18}H_{36}$ or C_nH_{2n} isomer (background)
9	191	.888	n-hexadecane	21	247	1.233	unknown
10	200	.941	unknown	22	263	1.335	butyl benzyl phthalate
11	203	.958	1,1,3-trimethyl-3-phenyl indan or $C_{18}H_{20}$ isomer (background)	23	265	1.484	di-isooctyl phthalate (background)
11A	204	.960	n-heptadecane	24	265	1.577	unknown

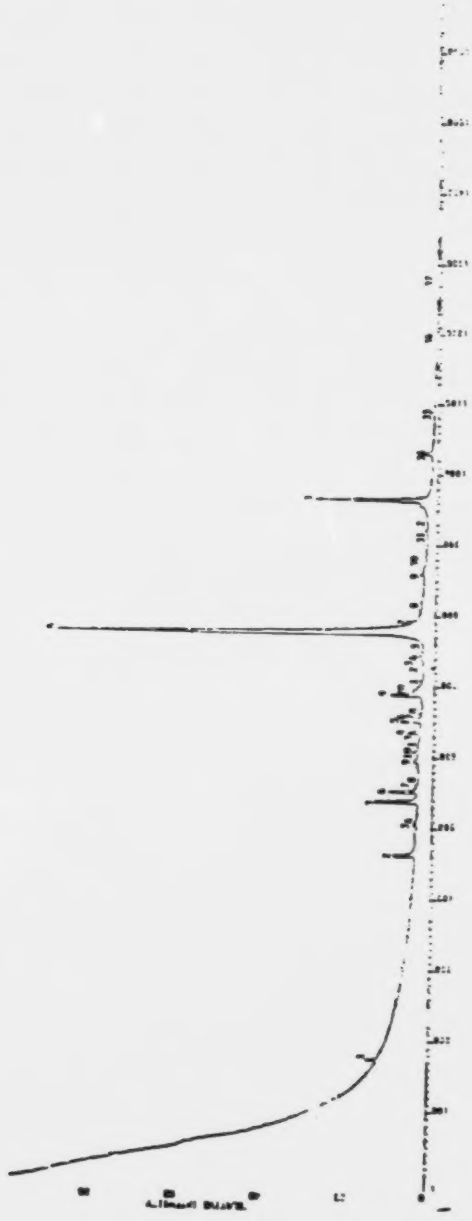

Figure G2. Total ion current chromatogram of extract from dichotomous filter No. 4F-012.

TABLE G2. COMPOUNDS TENTATIVELY IDENTIFIED FROM DICHOTOMOUS SAMPLE #4F-012

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	97	.269	satd. hydrocarbon (tent)
1A	98	.274	silane compound
1B	101	.291	satd. hydrocarbon
2	168	.726	dimethyl phthalate
2A	176	.780	unknown
3	179	.795	C_9-alkyl phenol isomer
4	180	.802	n-pentadecane
5	188	.846	diethyl phthalate
6	191	.869	2,2,4-trimethyl penta-1,3-diol di-isobutyrate (BKG)
7	192	.874	$C_{16}H_{32}$ isomer
8	193	.883	n-hexadecane
9	202	.937	unknown
10	205	.957	1,1,3-trimethyl-3-phenyl indan (background)
11	205	.961	n-heptadecane
~~12~~ 11A	206	.973	fluoro-chloro compound (tent)
13	207	.978	satd. hydrocarbon (tent)
14	212	1.000	d_{10}-anthracene (int. std.)
15	215	1.025	$C_{18}H_{36}$ isomer
16	216	1.033	n-octadecane
17	218	1.046	satd. hydrocarbon
18	219	1.054	alkyl phthalate
19	225	1.083	unknown
20	226	1.093	unsatd. hydrocarbon
21	230	1.117	dibutyl phthalate
21A	233	1.134	satd. hydrocarbon
22	234	1.143	fluoro-chloro compound
23	237	1.161	unsatd. hydrocarbon
24	238	1.170	satd. hydrocarbon
25	240	1.189	satd. hydrocarbon
26	247	1.220	$C_{18}H_{36}$ isomer or unsat. hydrocarb
27	250	1.252	unsatd. hydrocarbon
28	257	1.293	satd. hydrocarbon
29	265	1.339	butyl-benzyl phthalate
30	265	1.383	satd. hydrocarbon
30A	265	1.402	alkyl phthalate
31	265	1.452	alkyl phthalate
32	265	1.480	alkyl phthalate
33	265	1.513	di-isooctyl phthalate
34	265	1.622	unknown
35	265	1.713	alkyl phthalate
36	265	1.882	alkyl phthalate
37	265	2.016	alkyl phthalate

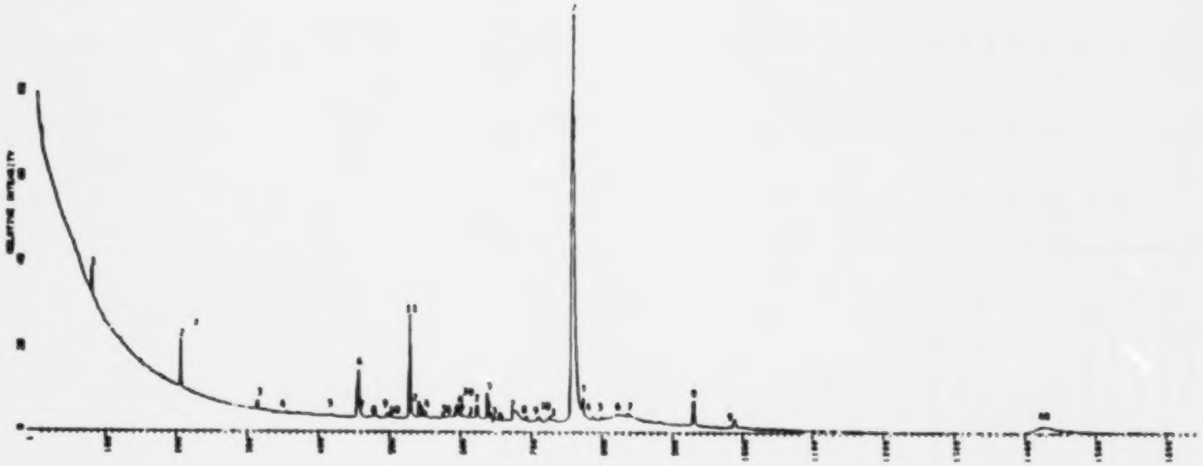

Figure G3. Total ion current chromatogram of extract from dichotomous filter No. 4F-018.

TABLE G3. COMPOUNDS TENTATIVELY IDENTIFIED FROM DICHOTOMOUS SAMPLE #4F-018

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	106	.128	hexamethylcyclotrisiloxane
2	133	.154	octamethylcyclotetrasiloxane
3	143	.504	decamethylcyclopentasiloxane
4	149	.570	unsatd. hydrocarbon (tent)
5	158	.671	silane compound
6	168	.732	dimethyl phthalate (background)
7	172	.756	satd. hydrocarbon (tent)
8	174	.767	satd. hydrocarbon
9	179	.798	C_9-alkyl phenol isomer
9A	179	.804	$C_{15}H_{32}$ isomer
10	181	.822	silane compound
11	186	.848	diethyl phthalate (background)
12	190	.870	2,2,4-trimethyl penta-1,3-diol di-isobutyrate (BKG)
13	191	.873	$C_{16}H_{32}$ isomer
14	192	.883	*n*-hexadecane
15	198	.923	$C_{17}H_{36}$ isomer
16	200	.937	unknown
17	202	.955	1,1,3-trimethyl-3-phenylindan or $C_{18}H_{20}$ isomer (background)
18	203	.958	*n*-heptadecane
19	204	.968	$C_{17}H_{34}$ isomer
20	206	.976	unsatd. hydrocarbon (tent)
21	207	.982	C_{10}-alkyl phenol isomer (tent)
22	210	1.000	d_{10}-anthracene (int. std.)
23	213	1.022	$C_{18}H_{36}$ isomer
24	214	1.029	$C_{18}H_{38}$ isomer
25	216	1.040	$C_{18}H_{36}$ isomer
26	218	1.048	alkyl phthalate
27	222	1.082	unknown
28	227	1.111	dibutyl phthalate
29	231	1.138	fluoro-chloro compound (unknown)
30	232	1.144	satd. hydrocarbon
30A	234	1.161	unsatd. hydrocarbon
31	235	1.165	satd. hydrocarbon
31A	240	1.201	$C_{18}H_{36}$ isomer
32	243	1.213	$C_{18}H_{36}$ isomer (background)
33	246	1.241	satd. hydrocarbon
34	250	1.263	silane compound
35	253	1.297	satd. hydrocarbon
36	259	1.316	unknown
37	262	1.343	alkyl phthalate isomer
38	265	1.491	di-isooctyl phthalate (background)
39	265	1.586	unknown
40	265	2.284	silane compound (tent)

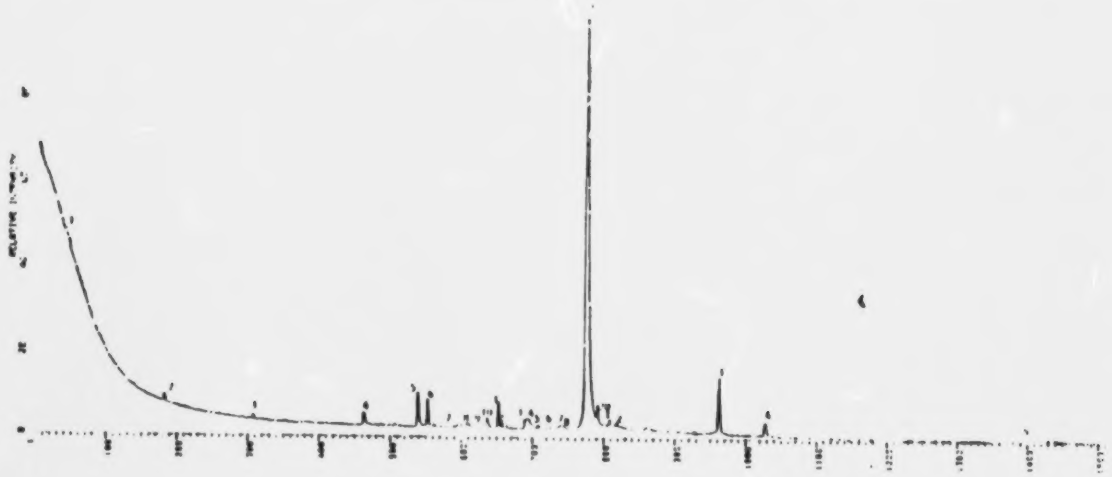

Figure G4. Total ion current chromatogram of extract from dichotomous filter No. 4F-021.

TABLE G4 COMPOUNDS TENTATIVELY IDENTIFIED FROM DICHOTOMOUS SAMPLE #4F-021

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound	Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	64	.064	hexamethylcyclotrisiloxane	10	212	1.000	d_{10}-anthracene (int. std.)
2	99	.286	octamethylcyclotetra-siloxane	11	215	1.025	$C_{18}H_{36}$ isomer
				12	217	1.031	n-octadecane
3	130	.483	decamethylcyclopenta-siloxane	12A	220	1.052	alkyl phthalate
				13	225	1.083	unknown
4	169	.726	dimethyl phthalate (background)	14	226	1.093	unsatd. hydrocarbon
				15	229	1.113	dibutyl phthalate
4A	180	.786	C_9-alkyl phenol isomer	16	234	1.143	fluoro chloro compound (tent)
4B	181	.800	n-pentadecane	17	237	1.160	unsatd. hydrocarbon
5	188	.846	diethyl phthalate	18	238	1.167	satd. hydrocarbon
			(background)	19	246	1.216	$C_{18}H_{36}$ or unsat. hydrocarbon (background)
6	191	.868	2,2,4-trimethylpenta-1,3-diol di-isobutyrate(BEC)	20	250	1.241	satd. hydrocarbon
6A	192	.873	n-hexadecane	21	254	1.274	silane compound (tent)
7	202	.936	unknown	22	265	1.349	butyl-benzyl phthalate
8	205	.956	1,1,3-trimethyl-3-phenyl-indan or $C_{18}H_{20}$ isomer (background)	23	265	1.511	di-isooctyl phthalate (background)
				24	265	1.613	unknown
9	207	.959	n-heptadecane	25	265	2.201	unknown

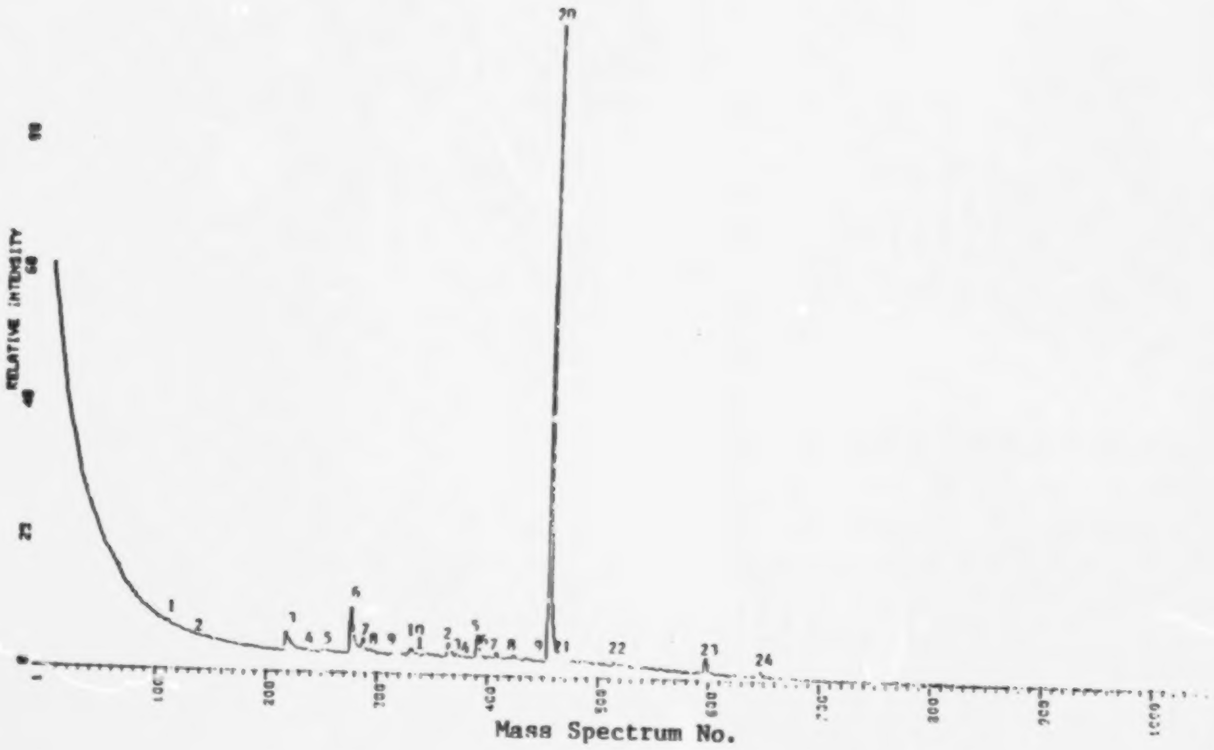

Figure G5. Total ion current chromatogram of extract from dichotomous filter No. 4F-022.

TABLE G5. COMPOUNDS TENTATIVELY IDENTIFIED FROM DICHOTOMOUS SAMPLER #4F-022

Chromato-grahic Peak No.	Elution Temp. (°C)	Relative Retention Time*	Compound	Chromato-grahpic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	150		satd. hydrocarbon (tent)	11	209		satd. hydrocarbon
2	154		satd. hydrocarbon	12	217		$C_{18}H_{36}$ or C_nH_{2n} isomer
3	170		dimethyl phthalate	13	218		n-octadecane
			(background)	14	220		alkyl phthalate
4	175		satd. hydrocarbon	15	226		unknown
5	182		C_9-alkyl phenol	16	230		satd. hydrocarbons
6	189		diethyl phthalate	17	232		dibutyl phthalate
			(background)	18	237		satd. hydrocarbons
7	193		2,2,4-trimethyl	19	244		satd. hydrocarbons
			penta-1,3-diol	20	248		$C_{18}H_{36}$ isomer (background)
			di-isobutyrate (BKG)	21	252		satd. hydrocarbons
8	195		n-hexadecane	22	265		satd. hydrocarbons (tent)
8A	201		satd. hydrocarbon	23	265		di-isooctyl phthalate
9	203		unknown				(background)
10	207		1,1,3-trimethyl-3-	24	265		unknown
			phenylindan (tent)				
			(traces) (background)				

APPENDIX H

ORGANICS IDENTIFIED FROM HI-VOL FILTERS

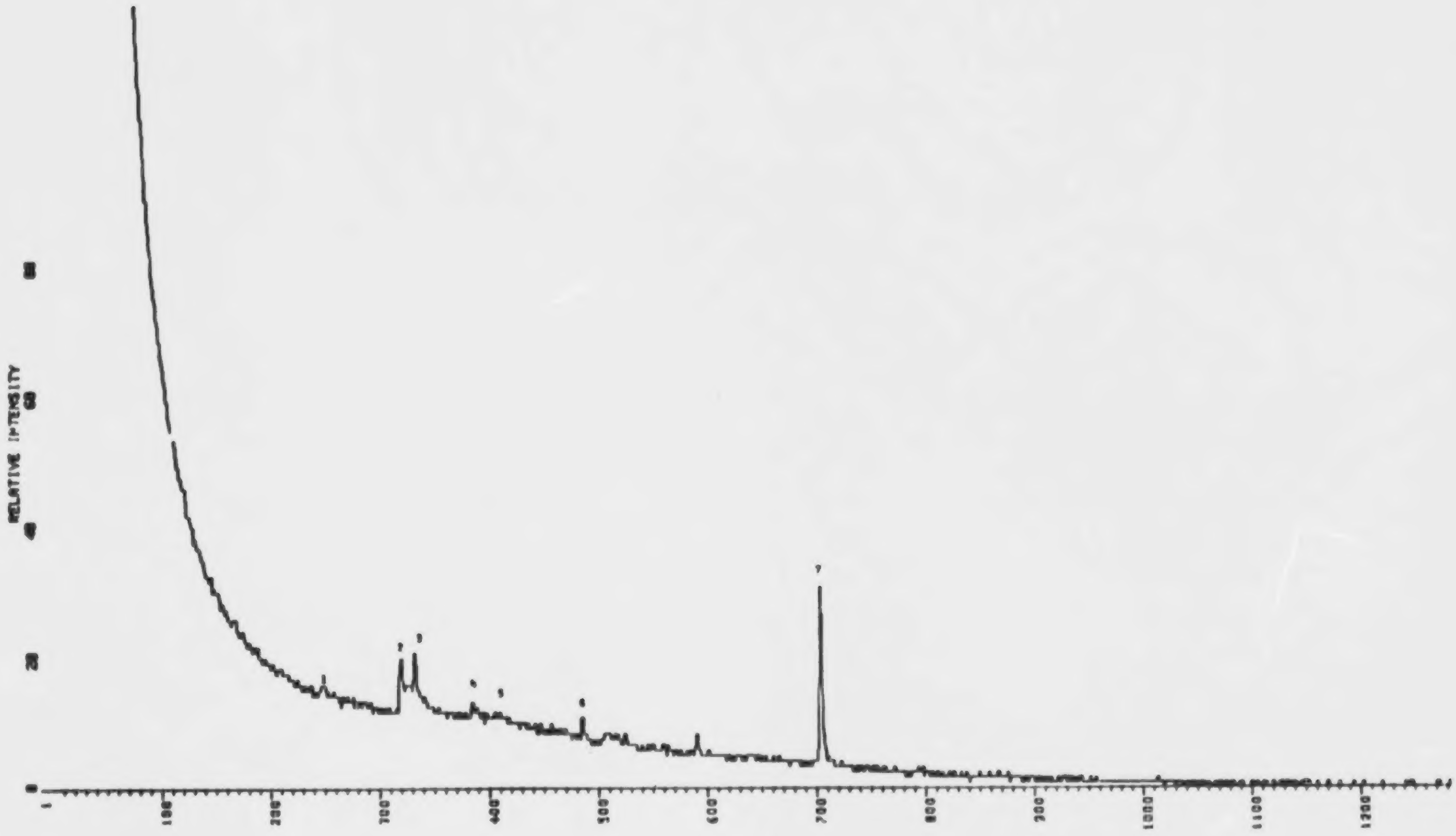

Figure H1. TIC - Acid fraction from Hi-Vol filter extract, filter #0012.

TABLE H1. COMPOUNDS IDENTIFIED FROM ACID FRACTION, HI-VOL FILTER #0012

Chromato-graphic Peak No.	Elution Temp. (°C)	Compound	Chromato-graphic Peak No.	Elution Temp. (°C)	Compound
1	188	dimethyl terephthalate	5	253	$C_{14}H_{10}$ isomer (phenanthrene, anthracene, diphenyl acetylene)
2	216	diethyl phthalate	6	265	phthalate
3	224	phthalate	7	265	di-nor-octyl phthalate
4	243	methoxy-di-*t*-butyl phenol isomer			

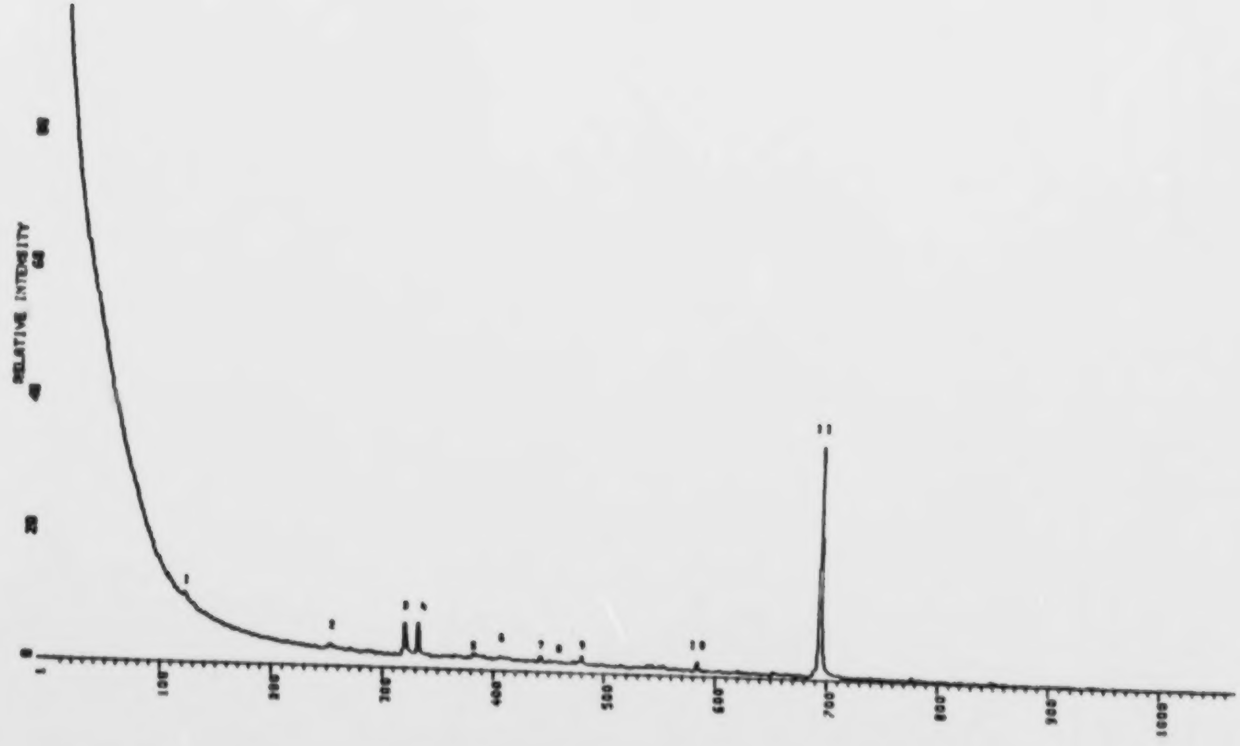

Figure H2. TIC - Base fraction from Hi-Vol filter extract, filter #0012.

TABLE H2. COMPOUNDS IDENTIFIED FROM BASE FRACTION, HI-VOL FILTER #0012

Chromatographic Peak No.	Elution Temp. (°C)	Compound
1	138	Unknown
2	190	dimethyl isophthalate (tent.)
3	217	diethyl phthalate
4	221	2,2,4-trimethyl penta-1,3-diol di-isobutyrate (bkg)
5	242	methoxy-di-_t_-butyl phenol isomer (tent.)
6	252	$C_{14}H_{10}$ isomer
7	265	n-butyl isobutyl phthalate
8	265	unknown
9	265	phthalate
10	265	sat. hydrocarbon
11	265	di-nor-octyl phthalate

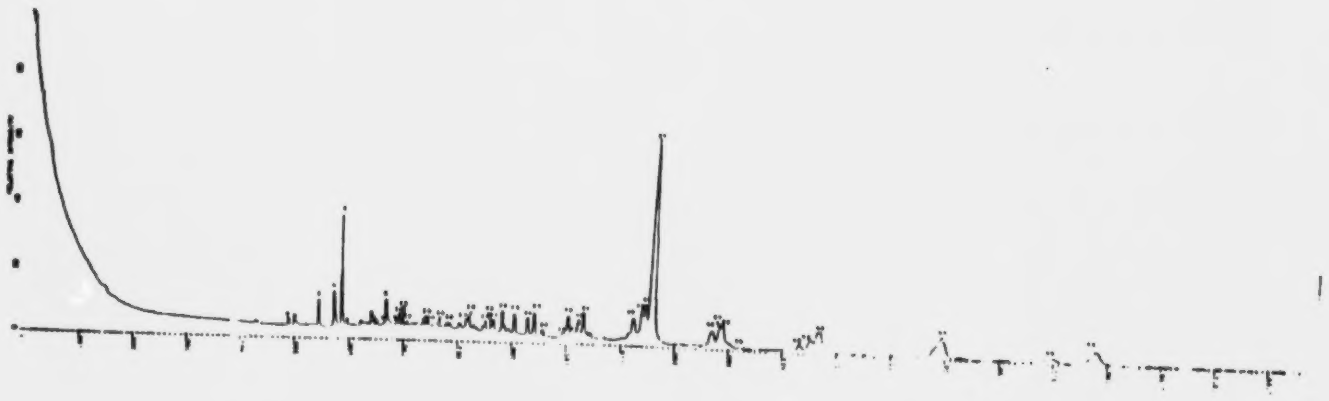

Figure H3. TIC - NPN fraction from Hi-Vol filter extract, Filter #0012.

TABLE H3. COMPOUNDS IDENTIFIED FROM NPN FRACTION, HI-VOL FILTER #0012

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	265	.731	$C_{14}H_{30}$ isomer
2	265	.748	dimethyl phthalate
3	265	.816	$C_{15}H_{32}$ isomer
4	265	.858	diethyl phthalate
5	265	.879	2,2,4-trimethyl penta-1,3-diol di-isobutyrate (bkg)
6	265	.961	trimethyl-3-phenyl-indane isomer
7	265	.997	$C_{14}H_{10}$ isomer
8	265	1.000	d_{10} anthracene (int. std.)
9	265	1.031	phthalate
10	265	1.036	phthalate
11	265	1.043	phthalate
12	265	1.055	phthalate
13	265	1.111	unknown
14	265	1.117	phthalate
15	265	1.145	$C_{19}H_{14}$ isomer (methylbenzo-anthracene or methylbenzo-phenanthrene isomer)(tent.)
16	265	1.177	$C_{20}H_{16}$ isomer (dimethylbenzo-anthracene or dimethylbenzo-phenanthrene isomer)(tent.)
17	265	1.222	$C_{18}H_{36}$ isomer
18	265	1.229	$C_{22}H_{46}$ isomer
19	265	1.276	$C_{22}H_{46}$ isomer
20	265	1.291	sat'd hydrocarbon
21	265	1.298	$C_{22}H_{46}$ isomer
22	265	1.319	$C_{18}H_{36}$ isomer
23	265	1.354	$C_{23}H_{48}$ isomer
24	265	1.393	$C_{23}H_{48}$ isomer
25	265	1.411	$C_{23}H_{48}$ isomer
26	265	1.433	$C_{23}H_{48}$ isomer
27	265	1.489	$C_{24}H_{50}$ isomer
28	265	1.502	$C_{24}H_{50}$ isomer
29	265	1.523	unknown
30	265	1.531	$C_{24}H_{50}$ isomer
31	265	1.544	$C_{24}H_{50}$ isomer
32	265	1.679	$C_{25}H_{52}$ isomer
33	265	1.708	phthalate
33A	265	1.708	$C_{25}H_{52}$ isomer
34	265	1.717	phthalate
34A	265	1.717	$C_{25}H_{52}$ isomer
35	265	1.727	bis(2-ethyl hexyl) phthalate
36	265	1.900	$C_{26}H_{54}$ isomer
37	265	1.922	$C_{26}H_{54}$ isomer
38	265	1.931	$C_{26}H_{54}$ isomer
39	265	1.979	phthalate
40	265	2.144	phthalate
41	265	2.172	$C_{27}H_{56}$ isomer
42	265	2.195	$C_{27}H_{56}$ isomer
43	265	2.516	$C_{28}H_{56}$ isomer
43A	265	2.520	$C_{28}H_{58}$ isomer
43B	265	2.531	$C_{28}H_{58}$ isomer
43C	265	2.535	$C_{28}H_{58}$ isomer
44	265	2.846	phthalate
45	265	2.957	sat'd hydrocarbon

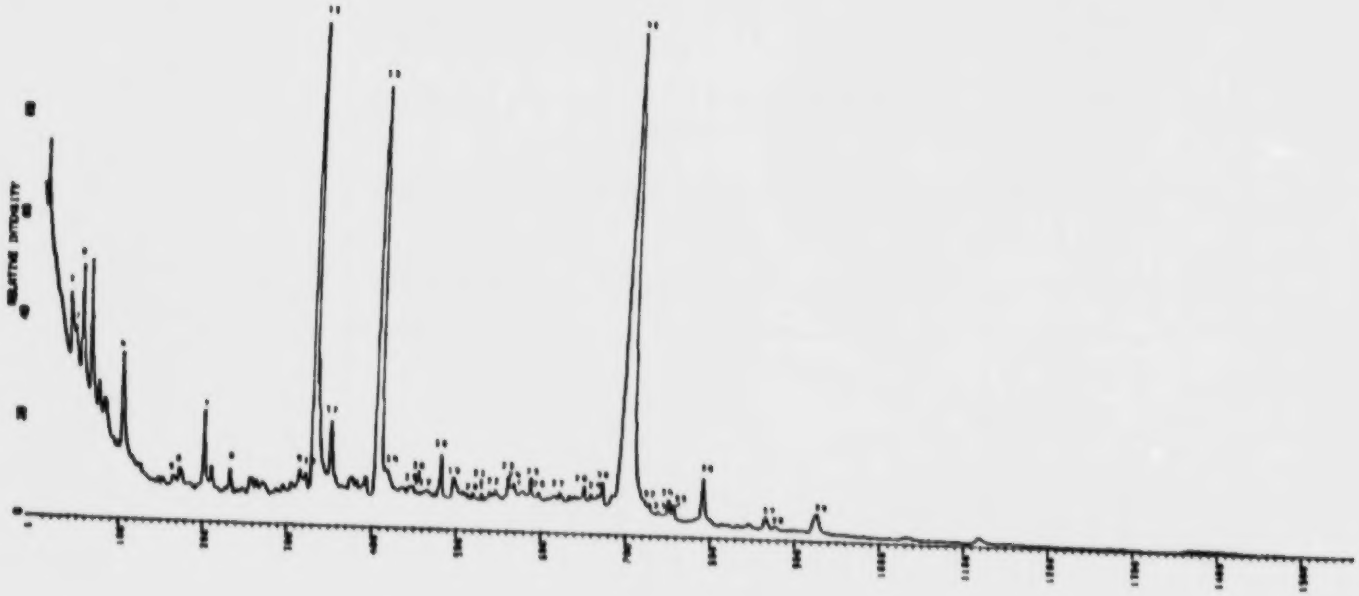

Figure H4. TIC - PNA fraction from Hi-Vol filter extract, Filter #0012.

TABLE H4. COMPOUNDS IDENTIFIED FROM PNA FRACTION, HI-VOL FILTER #0012

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	110°	.098	unknown
2	114°	.134	unknown
3	116°	.151	unknown
4	125°	.244	unknown
5	141°	.398	methyl-acetylacetone isomer (tent.)
6	143°	.420	unknown
7	150°	.485	unsat'd hydrocarbon (tent.)
8	158°	.563	$C_{11}H_{24}$ isomer
9	180°	.761	unknown
10	181°	.766	diethyl phthalate
11	185°	.798	2,2,4-trimethyl penta-1,3-diol di-isobutyrate (bkg.)
12	189°	.854	tributyl phosphate
13	204°	.980	$C_{14}H_{10}$ isomer (anthracene, phenanthrene or diphenylacetylene)
14	210°	1.000	d_{10} anthracene (int. std.)
15	213°	1.080	phthalate
16	214°	1.088	unknown
17	218°	1.137	$C_{14}H_{10}$ isomer
18	222°	1.171	dibutyl phthalate
19	226°	1.205	$C_{20}H_{16}$ isomer
20	232°	1.266	$C_{16}H_{10}$ isomer (fluoranthene or pyrene)
21	235°	1.290	diphenylthiophene isomer (tent).
22	239°	1.312	$C_{16}H_{10}$ isomer
23	243°	1.366	unknown
24	250°	1.380	unknown
25	250°	1.434	sat'd hydrocarbon
26	252°	1.451	phthalate
27	259°	1.515	butyl benzyl phthalate
28	265	1.583	unknown
29	265	1.610	$C_{18}H_{12}$ isomer (tent.) (benzanthracene, chrysene or triphenylene)
30	265	1.637	phthalate
31	265	1.690	di-nor-octyl phthalate
32	265	1.776	phthalate
33	265	1.800	phthalate
34	265	1.827	phthalate
35	265	1.841	phthalate
36	265	1.924	phthalate
37	265	2.105	phthalate
38	265	2.134	phthalate
39	265	2.251	phthalate

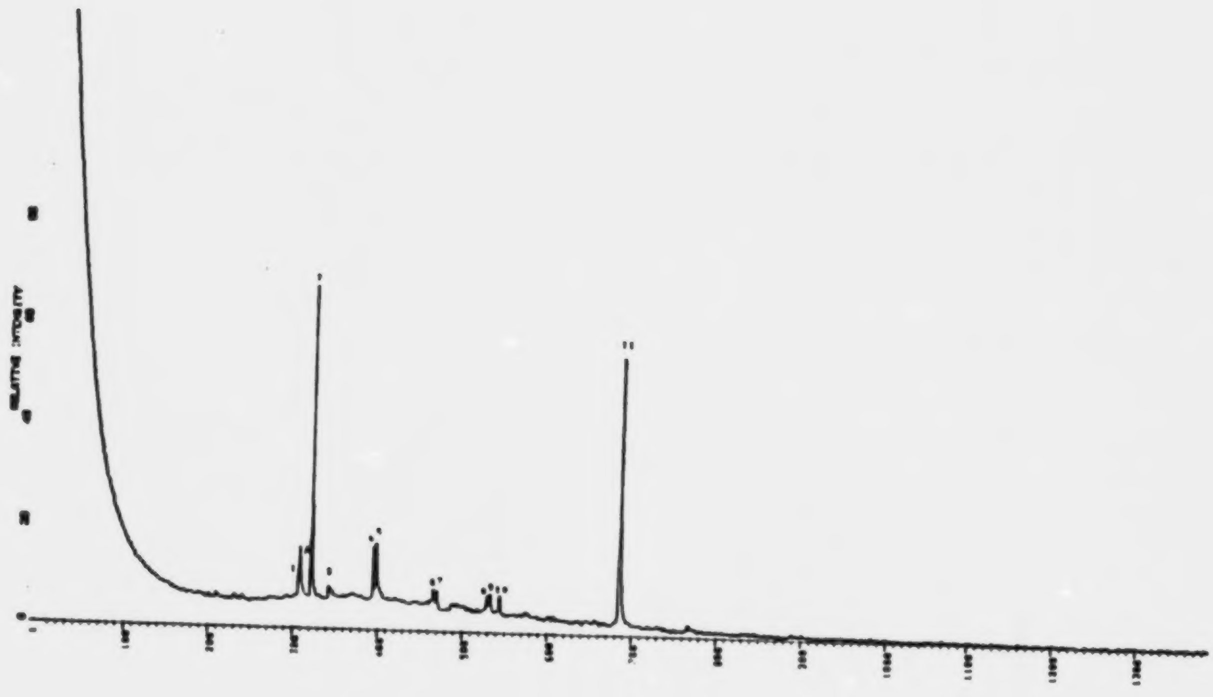

Figure H5. TIC - PN fraction from Hi-Vol filter extract, Filter #0012.

TABLE H5. COMPOUNDS IDENTIFIED FROM PN FRACTION, HI-VOL FILTER #0012

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	212	.771	unknown
1A	213	.774	diethyl phthalate
2	218	.807	2,2,4-trimethyl penta-1,3-diol di-isobutyrate (bkg)
3	227	.862	tributyl phosphate
4	247	.990	$C_{14}H_{10}$ isomer
5	249	1.000	d_{10} anthracene (std.)
6	265	1.171	unsat. hydrocarbon
7	265	1.178	phthalate
8	265	1.329	sat. hydrocarbon
9	265	1.337	sat. hydrocarbon
10	265	1.364	unsat. hydrocarbon
11	265	1.716	di-nor-octyl phthalate

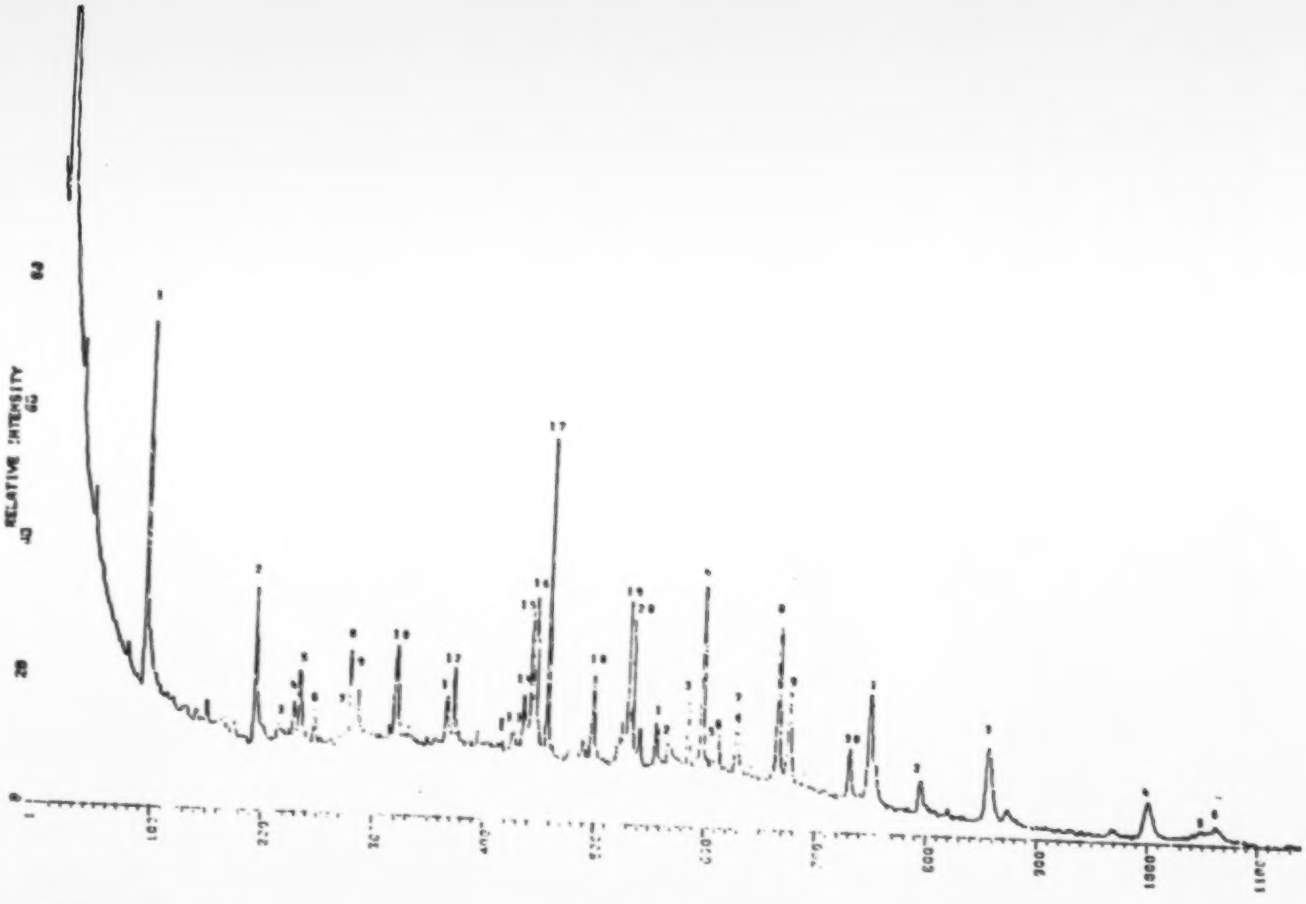

Figure H6. TIC - Acid fraction from Hi-Vol filter extract, filter #0013.

TABLE H6. COMPOUNDS IDENTIFIED FROM ACID FRACTION, HI-VOL FILTER #0013

Chromatographic Peak No.	Elution Temp. (°C)	Compound	Chromatographic Peak No.	Elution Temp. (°C)	Compound
1	139	siloxane	19	253	siloxane
2	165	siloxane	20	254	methyl stearate
3	170	Br_2 compound	21	260	siloxane
4	174	siloxane	22	262	methyl-pyrene isomer
5	175	dimethyl phthalate	23	265	Br_2 compound
6	179	siloxane	24	265	siloxane
7	185	unsaturated hydrocarbon	25	265	siloxane
8	187	methyl laurate	26	265	siloxane
9	189	siloxane	27	265	saturated hydrocarbon
10	198	siloxane	28	265	siloxane
11	210	siloxane	29	265	siloxane
12	212	methyl tetradecanoate	30	265	saturated hydrocarbon
13	225	indene (tentative)	31	265	siloxane
14	228	siloxane	32	265	saturated hydrocarbon
15	230	siloxane	33	265	siloxane
16	231	siloxane	34	265	siloxane
17	233	methyl palmitate	35	265	unknown
18	244	siloxane	36	265	unknown

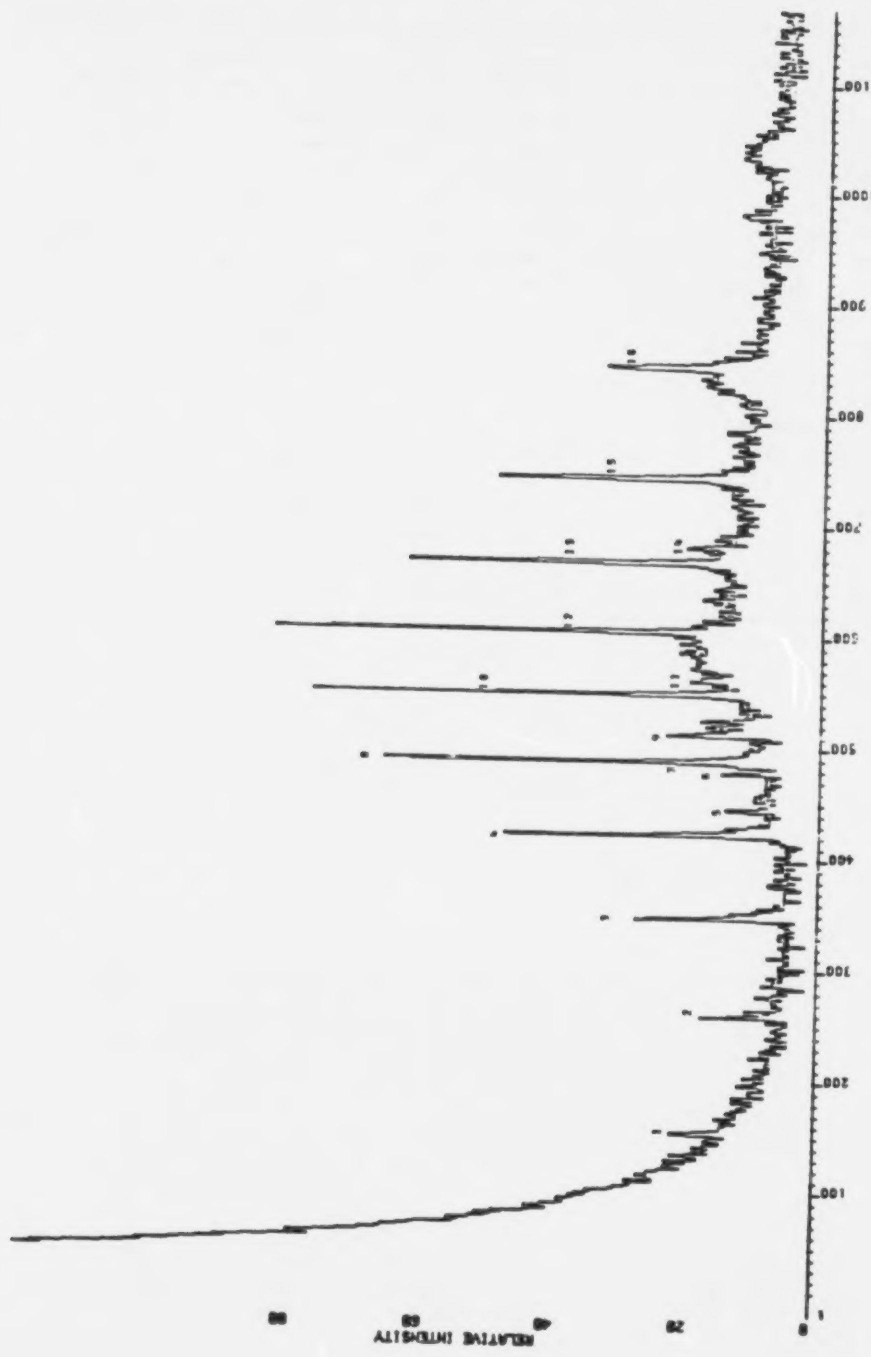

Figure H7. TIC - Base fraction from Hi-Vol filter extract, filter #0013.

TABLE H7. COMPOUNDS IDENTIFIED FROM BASE FRACTION, HI-VOL FILTER #0013

Chromato-graphic Peak No.	Elution Temp. (°C)	Compound	Chromato-graphic Peak No.	Elution Temp. (°C)	Compound
1	116	background	9	198	unknown
2	133	siloxane	10	209	siloxane
3	151	siloxane	11	215	$C_{17}H_{12}$ isomer (tentative)
4	173	siloxane	12	224	siloxane
5	180	sat'd methyl ester (tentative)	13	239	siloxane
6	190	unknown	14	244	dioctyl phthalate
7	193	indene (tentative)	15	254	siloxane
8	193	siloxane	16	265	siloxane

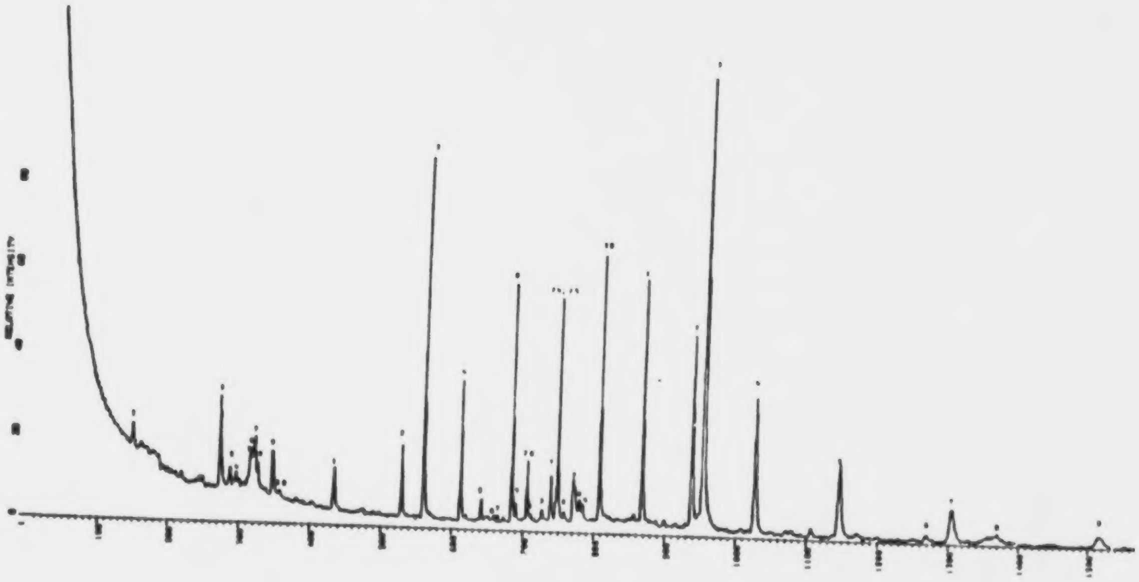

Figure H8. TIC - NPN fraction from Hi-Vol filter extract, Filter #0013.

TABLE H8. COMPOUNDS IDENTIFIED FROM NPN FRACTION, HI-VOL FILTER #0013

Chromato-graphic Peak No.	Elution Temp. (°C)	Compound
1	92	saturated hydrocarbon
2	124	*n*-undecane
3	128	*n*-dodecane
4	130	$C_{12}H_{26}$ isomer
5	135	saturated hydrocarbon
6	136	$C_{12}H_{26}$ isomer
7	137	$C_{12}H_{26}$ isomer
8	138	$C_{10}H_{20}$ isomer (tentative)
9	143	saturated hydrocarbon
10	146	saturated hydrocarbon
11	166	siloxane
12	191	siloxane
13	198	2,2,4-trimethyl penta-1,3-diol di-isobutyrate
14	212	siloxane
15	219	siloxane
16	225	saturated hydrocarbon
17	226	saturated hydrocarbon
18	231	siloxane
19	232	siloxane
20	236	methyl palmitate
21	238	phthalate
22	242	unsaturated hydrocarbon
23	245	unsaturated hydrocarbon
24	248	indene
25	248	siloxane
26	250	alkyl indan (tentative)
27	253	alkyl indan (tentative)
28	256	alkyl indan (tentative)
29	257	methyl stearate
30	263	siloxane
31	265	siloxane
32	265	siloxane
33	265	di-*n*-octyl phthalate
34	265	siloxane
35	265	siloxane
36	265	saturated hydrocarbon
37	265	siloxane
38	265	alkyl indan (tentative)
39	265	siloxane

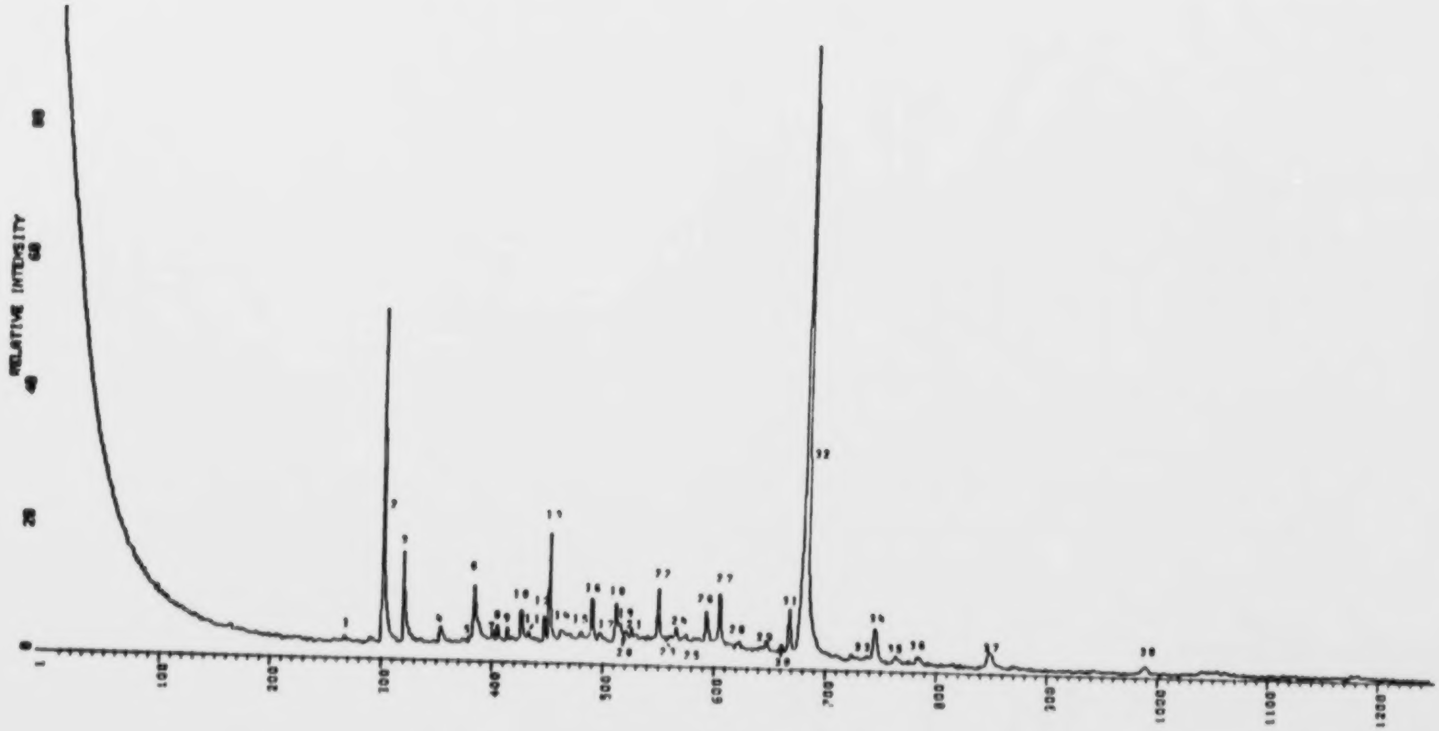

Figure H9. TIC - PNA fraction from Hi-Vol filter extract, filter #0013.

TABLE H9. COMPOUNDS IDENTIFIED FROM PNA FRACTION, HI-VOL FILTER #0013

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	183°	0.752	diethyl phthalate
2	194°	.786	2,2,4-trimethyl penta-1,3-diol di-isobutyrate (bkg)
3	199°	.833	tributyl phosphate
4	207°	.922	siloxane
5	214°	.995	anthracene isomer
6	215°	1.000	d_{10}-anthracene (int. std.)
7	220°	1.044	phenanthrene isomer
8	221°	1.055	unknown
9	223°	1.078	dibutyl phthalate isomer
10	226°	1.112	siloxane
11	228°	1.131	d_5-phenol (int. std.)
12	231°	1.164	methyl palmitate (tentative)
13	233°	1.175	di-*n*-butyl phthalate
14	236°	1.206	fatty acid (tentative)
15	241°	1.269	indene (tentative)
16	242°	1.279	siloxane
17	244°	1.295	diphenyl acetylene (tentative)
18	248°	1.334	unknown
19	249°	1.337	unknown
20	251°	1.358	indene (tentative)
21	252°	1.373	phthalate
22	258°	1.433	siloxane
23	260°	1.465	$C_{17}H_{12}$ isomer
24	262°	1.475	phthalate + unknown
25	265°	1.499	phthalate
26	265°	1.546	butyl benzyl phthalate
27	265°	1.580	siloxane
28	265°	1.624	unknown
29	265°	1.687	phthalate
30	265°	1.723	dioctyl phthalate isomer
31	265°	1.742	siloxane
32	265°	1.778	dioctyl phthalate isomer
33	265°	1.927	phthalate
34	265°	1.945	siloxane
35	265°	1.992	unknown
36	265°	2.044	phthalate
37	265°	2.214	siloxane
38	265°	2.577	siloxane

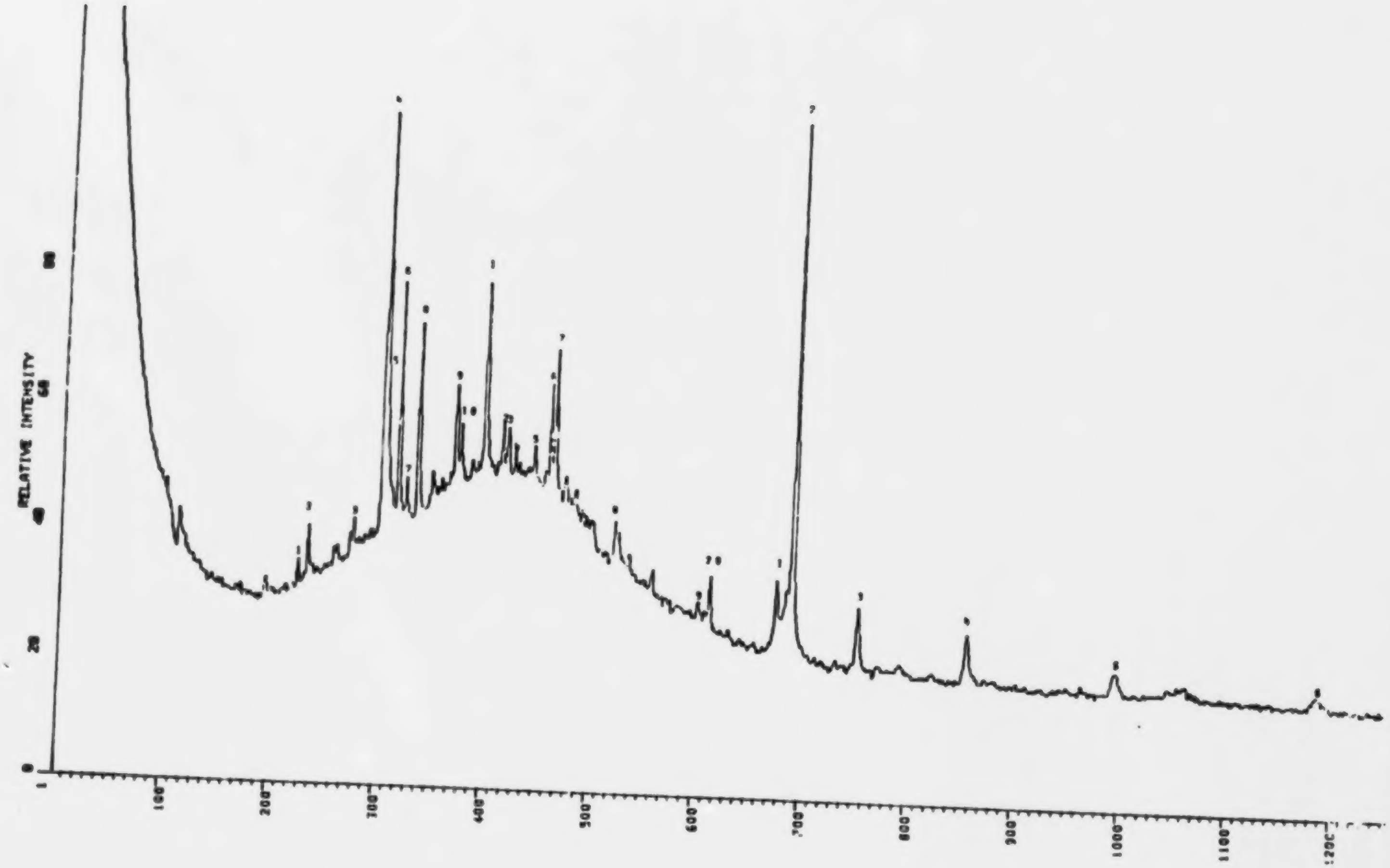

Figure H10. TIC - PN fraction, Hi-Vol filter #0013.

TABLE H10. COMPOUNDS IDENTIFIED FROM HI-VOL FILTER #0013

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	174	.568	saturated hydrocarbon
2	176	.591	dimethyl phthalate
3	187	.699	saturated hydrocarbon
4	193	.758	unknown
5	194	.765	diethyl phthalate
6	197	.798	2,2,4-trimethyl penta-1,3-diol di-isobutyrate
7	200	.813	saturated hydrocarbon
8	202	.932	tributyl phosphate
9	211	.934	1,1,3-trimethyl-3-phenyl indane
10	213	.934	saturated hydrocarbon
11	217	1.000	d_{10} anthracene (int. std.)
12	223	1.035	$C_{18}H_{38}$ isomer
13	224	1.053	$C_{18}H_{38}$ isomer
14	226	1.073	phthalate
15	231	1.119	siloxane
16	234	1.164	methyl palmitate
17	235	1.164	phthalate
18	250	1.308	siloxane
19	265	1.518	phthalate
20	265	1.548	siloxane
21	265	1.705	siloxane
22	265	1.740	di-*n*-octyl phthalate
23	265	1.904	siloxane
24	265	2.159	siloxane
25	265	2.513	siloxane
26	265	2.987	siloxane

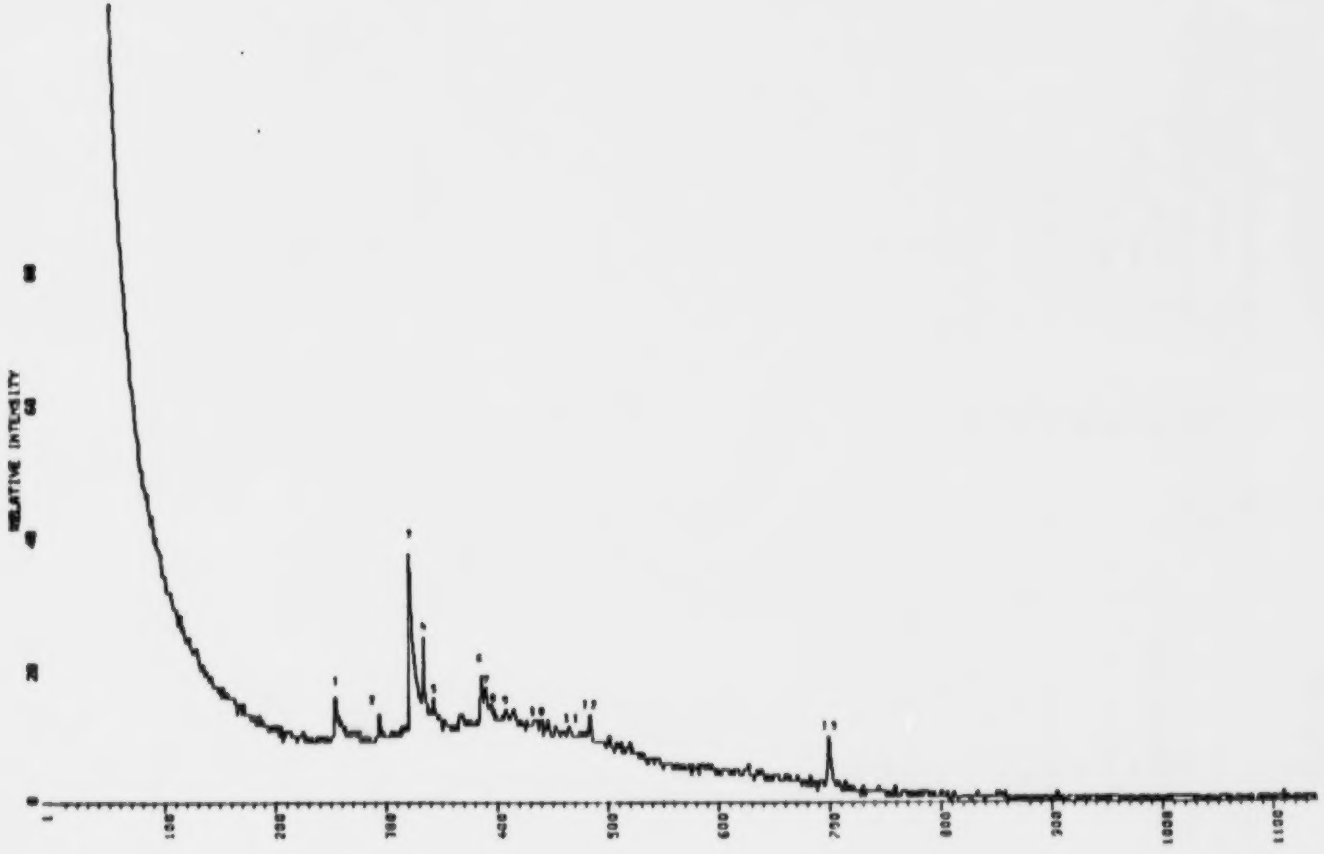

Figure H11. TIC - Acid fraction from Hi-Vol filter extract, filter #0014.

TABLE H11. COMPOUNDS IDENTIFIED FROM ACID FRACTION, HI-VOL FILTER #0014

Chromato-graphic Peak No.	Elution Temp. (°C)	Compound
1	164	dimethyl phthalate
2	174	phthalate
3	181	diethyl phthalate
4	184	2,2,4-trimethylpenta-1,3-diol di-isobutyrate (bkg)
5	187	phthalate
6	197	trimethyl-phenyl-indane isomer
7	198	phthalate
8	200	phthalate
9	203	sat'd hydrocarbon
10	213	sat'd hydrocarbon
11	218	phthalate
12	222	phthalate
13	265	di-nor-octyl phthalate

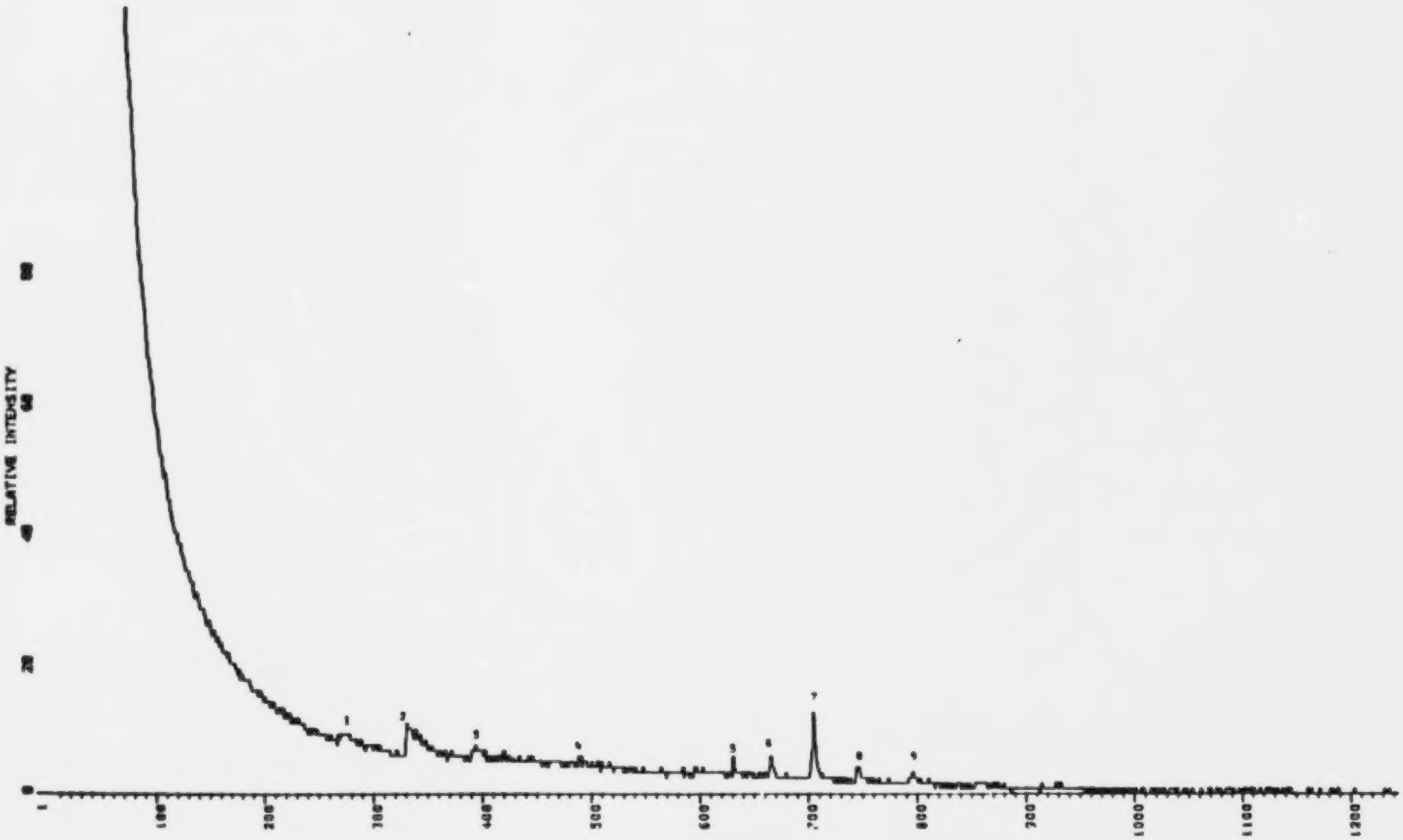

Figure H12. TIC - Base fraction from Hi-Vol filter extract, filter #0014.

TABLE H12. COMPOUNDS IDENTIFIED FROM BASE FRACTION, HI-VOL FILTER #0014

Chromato-graphic Peak No.	Elution Temp. (°C)	Compound
1	169	phthalate
2	183	diethyl phthalate
3	199	methoxy-di-t-butyl-phenol isomer (tent)
4	244	phthalate
5	260	siloxane
6	265	siloxane
7	265	di-nor-octyl phthalate
8	265	sat'd hydrocarbon (tentative)
9	265	siloxane

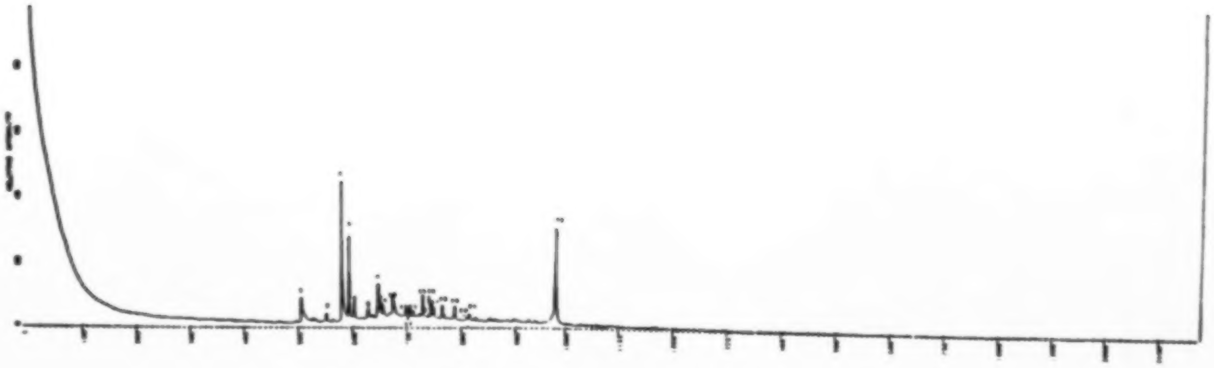

Figure H13. TIC - NPN fraction from Hi-Vol filter extract, Filter #0014.

TABLE H13. COMPOUNDS IDENTIFIED FROM NPN FRACTION, HI-VOL FILTER #0014

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	227	0.751	dimethyl phthalate
2	238	.819	$C_{15}H_{32}$ isomer (pentadecane, dimethyltridecane, methyltetradecane)
3	246	.861	ethyl phthalate
4	249	.880	2,2,4-trimethylpenta-1,3-diol di-isobutyrate (bkg)
5	251	.895	$C_{16}H_{34}$ isomer
6	258	.930	sat'd hydrocarbon
7	262	.960	trimethyl-phenyl-indane isomer
8	264	.966	$C_{17}H_{36}$ isomer
9	265	.972	sat'd hydrocarbon
10	265	1.000	d_{10}-anthracene (int. std)
11	265	1.036	$C_{18}H_{38}$ isomer
12	265	1.043	sat'd hydrocarbon
13	265	1.053	phthalate
14	265	1.082	siloxane
15	265	1.099	$C_{19}H_{40}$ isomer
16	265	1.105	unsat'd hydrocarbon
17	265	1.110	phthalate
18	265	1.135	octa-sulphur
19	265	1.169	unknown
20	265	1.203	sat'd hydrocarbon
21	265	1.208	sat'd hydrocarbon
22	265	1.454	di-nor-octyl phthalate

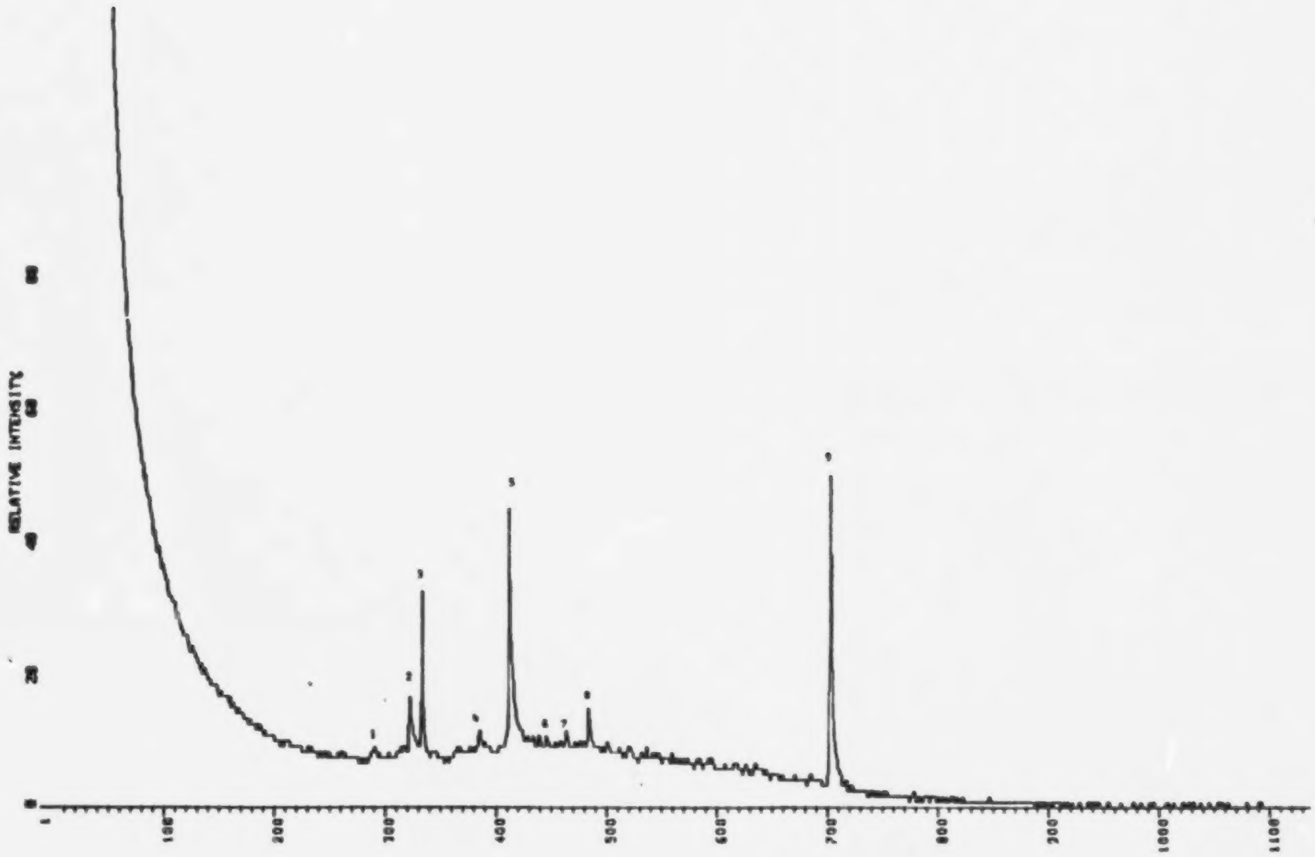

Figure H14. TIC - PNA fraction from Hi-Vol filter extract, filter #0014.

TABLE H14. COMPOUNDS IDENTIFIED FROM PNA FRACTION, HI-VOL FILTER #0014

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	173	0.703	phthalate
2	181	0.783	diethyl phthalate
3	184	.810	2,2,4-trimethylpenta-1,3-diol di-isobutyrate (bkg)
4	197	.934	trimethyl-phenyl-indane isomer (tentative)
5	203	1.000	d_{10}-anthracene (int. std.)
6	212	1.083	phthalate
7	217	1.126	siloxane (bkg)
8	222	1.175	phthalate
9	265	1.705	di-nor-octyl phthalate

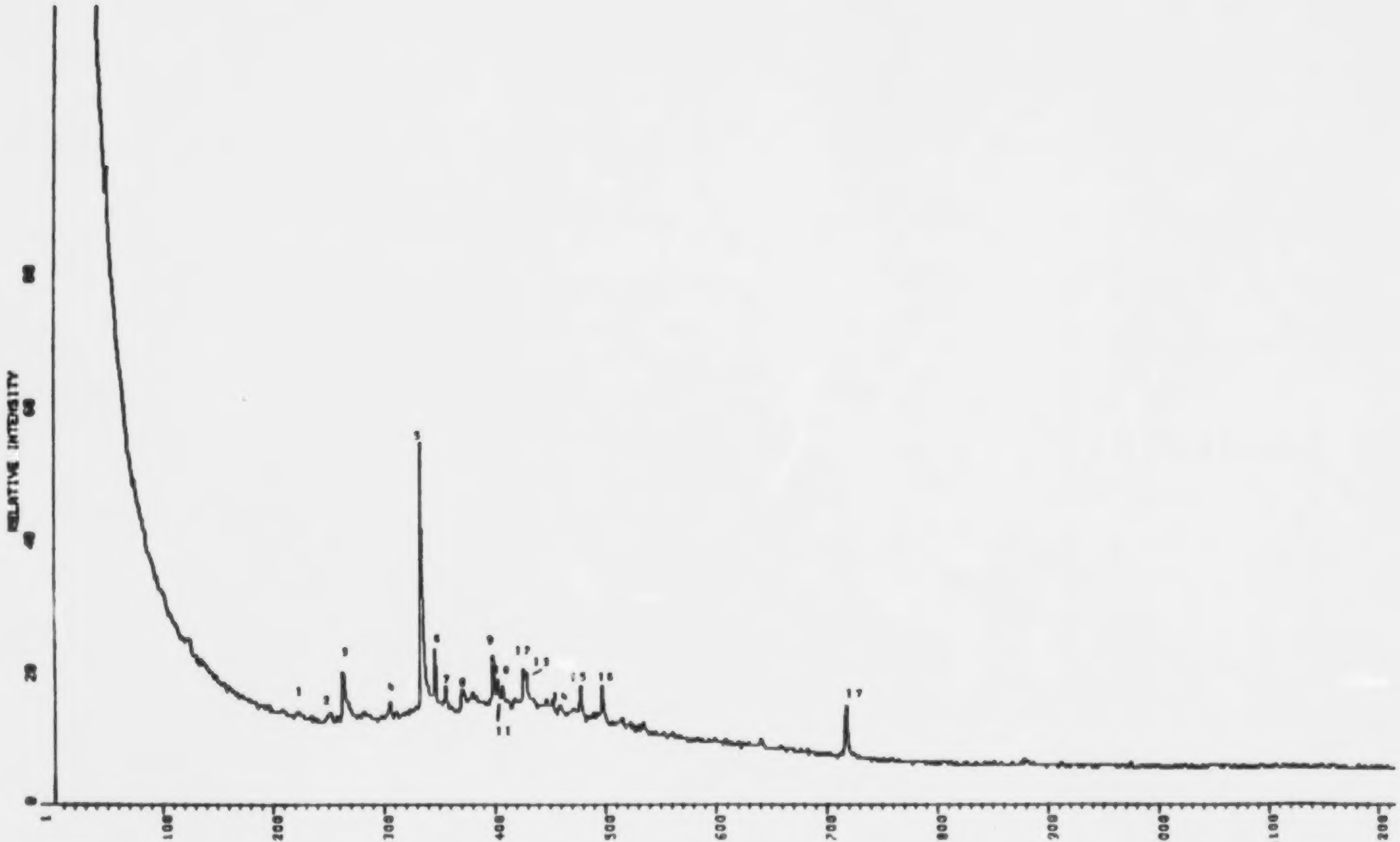

Figure H15. TIC - PN fraction from Hi-Vol filter extract, filter #0014.

TABLE H15. COMPOUNDS IDENTIFIED FROM PN FRACTION, HI-VOL FILTER #0014

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	155	0.520	phthalate
2	162	.595	phthalate
3	165	.616	dimethyl phthalate isomer
4	175	.725	phthalate
5	182	.781	diethyl phthalate
6	186	.812	2,2,4-trimethylpenta-1,3-diol di-isobutyrate (bkg)
7	189	.831	phthalate
8	192	.871	tri-butyl phosphate
9	199	.934	trimethyl-phenyl-indane isomer
10	200	.941	phthalate
11	202	.958	phthalate
12	206	1.000	d_{10}-anthracene (int. std.)
13	207	1.007	siloxane (bkg)
14	215	1.078	phthalate
15	219	1.122	siloxane (bkg)
16	224	1.167	phthalate
17	265	1.687	di-nor-octyl phthalate

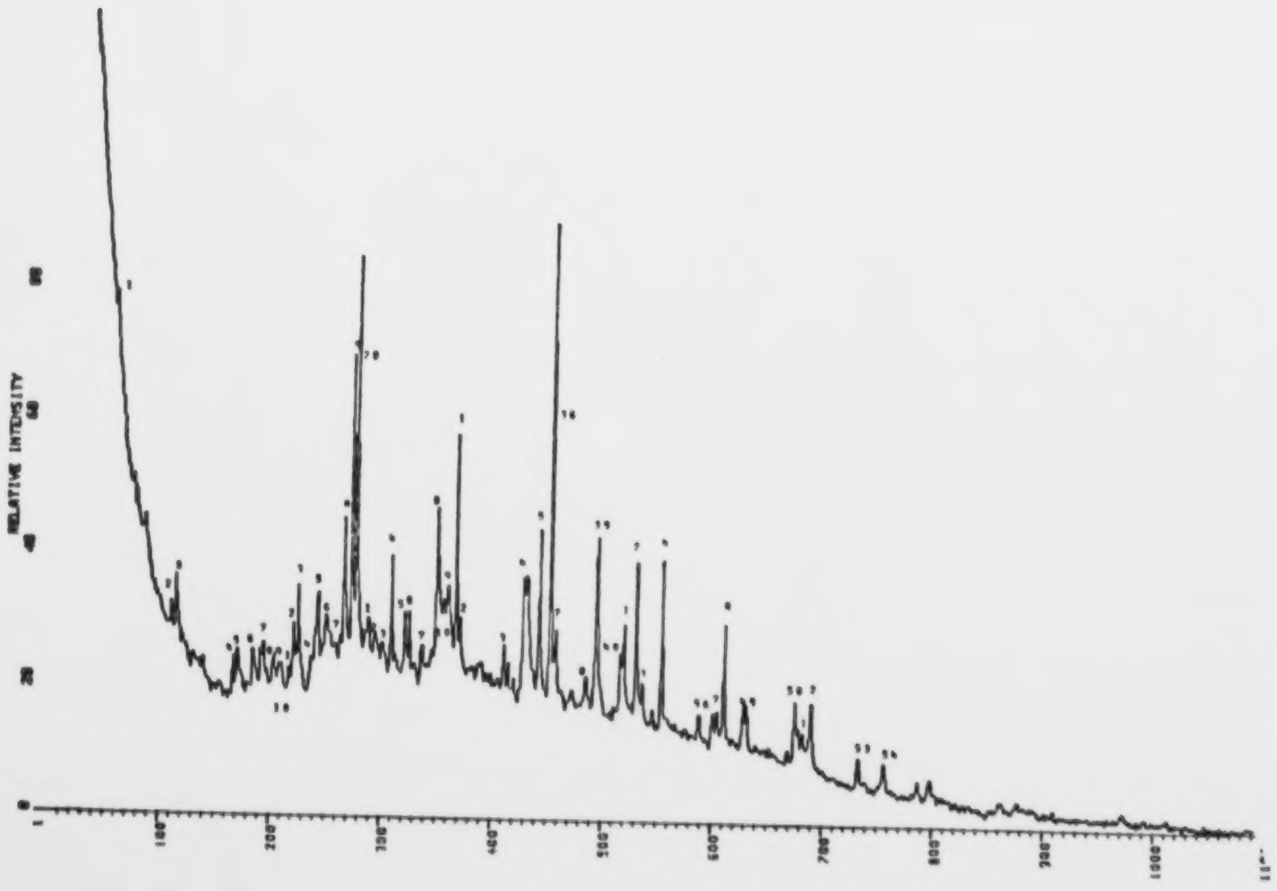

Figure H16. TIC - Acid fraction from Hi-Vol filter extract, Filter #0015.

TABLE H16. COMPOUNDS IDENTIFIED FROM ACID FRACTION, HI-VOL FILTER #0015

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	138°	0.227	dimethyl glutarate
2	144°	.443	$C_7H_{14}O_2$ methyl hexanoate
3	145°	.459	$C_8H_{14}O_4$ dimethyl adipate
4	159°	.675	saturated methyl ester
5	160°	.691	unknown
6	163°	.732	methyl 4-oxo-*n*-nonanoate
7	166°	.772	siloxane
8	168°	.817	C_3 alkylbenzene
9	168°	.821	di-*n*-propyl benzene
10	170°	.841	background
11	172°	.882	unknown hydrocarbon
12	173°	.894	$C_{12}H_{24}O_2$ isomer
13	174°	.910	methyl-4-methyl-heptane-1,7-dioate
14	177°	.980	background
15	178°	1.000	d_5 phenol (int. std.)
16	180°	1.016	methyl toluate (tentative)
17	184°	1.077	4-(2,5-xylyl)-butanoic acid (tentative)
18	185°	1.102	methyl undecanoate
19	186°	1.118	dimethyl decanedioate
20	187°	1.130	methyl nonane-1,9-dioate
21	190°	1.166	phthalate
22	182°	1.191	siloxane
23	194°	1.207	diethyl phthalate
24	196°	1.252	2,2,4-trimethyl-penta-1,3-diol diisobutyrate
25	199°	1.305	dimethyl phthalate
26	200°	1.317	unknown
27	203°	1.366	methyl ester
28	206°	1.402	phthalate
29	208°	1.419	siloxane
30	210°	1.439	siloxane
31	211°	1.488	methyl tetradecanoate
32	212°	1.500	phthalate
33	222°	1.667	saturated methyl ester
34	228°	1.736	siloxane
35	231°	1.797	unknown
36	233°	1.833	methyl palmitate (tentative)
37	234°	1.854	phthalate
38	242°	1.972	unknown
39	244°	2.008	siloxane
40	249°	2.098	unknown
41	250°	2.106	unknown
42	253°	2.150	methyl octadecanoate
43	255°	2.179	siloxane
44	259°	2.248	siloxane
45	265°	2.386	$C_{21}H_{44}$ isomer
46	265°	2.439	siloxane
47	265°	2.455	methyl dehydroabietate (tentative)
48	265°	2.480	siloxane
49	265°	2.553	unknown
50	265°	2.740	siloxane
51	265°	2.768	dioctyl phthalate
52	265°	2.797	phthalate
53	265°	2.967	unknown
54	265°	3.069	siloxane
55	265°	3.244	unknown

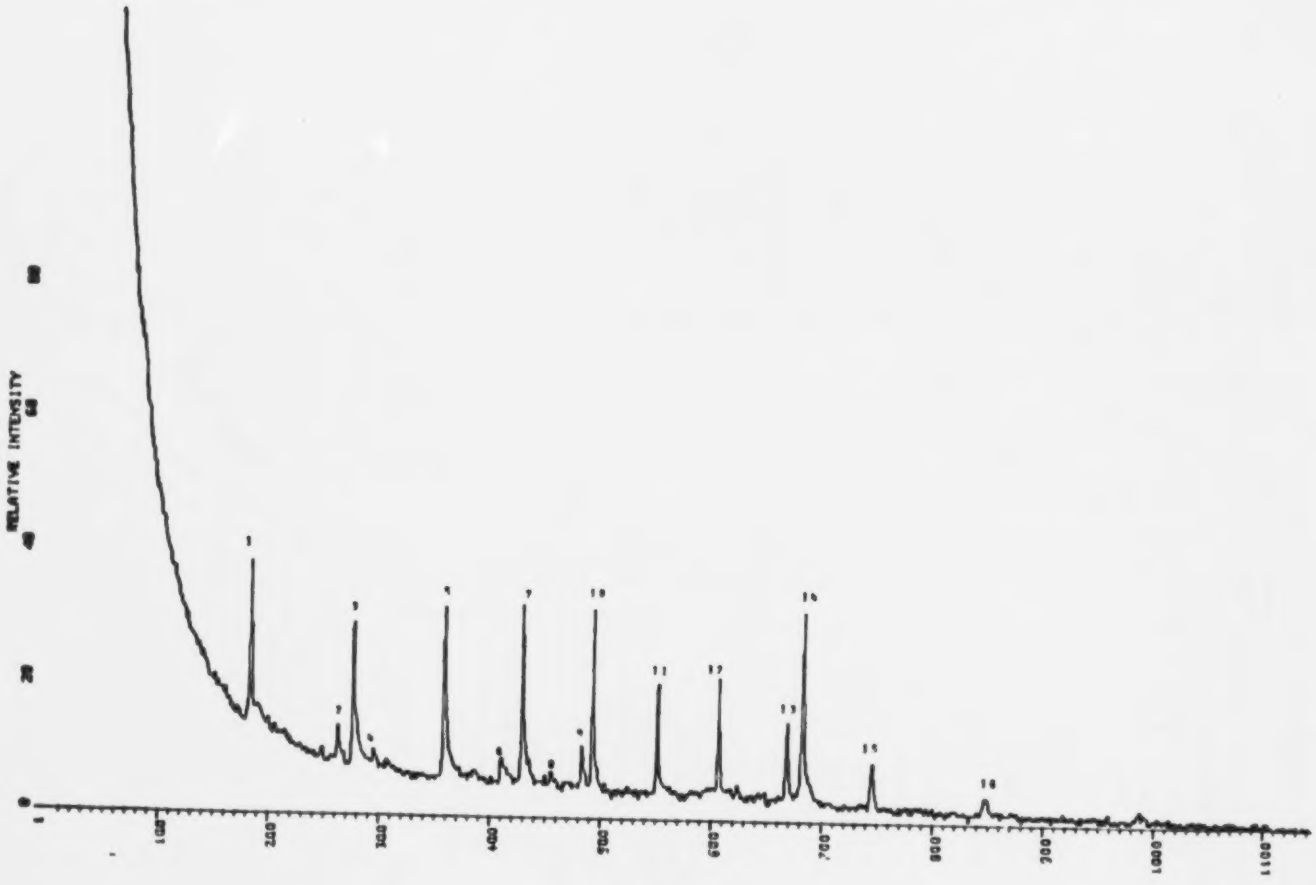

Figure H17. TIC - Base fraction from Hi-Vol filter extract, Filter #0015.

TABLE H17. COMPOUNDS IDENTIFIED FROM BASE FRACTION, HI-VOL FILTER #0015

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	162°	.446	siloxane
2	183°	.639	background
3	186°	.673	siloxane
4	194°	.720	diethyl phthalate
5	208°	.871	siloxane
6	222°	1.000	caffeine
7	226°	1.044	siloxane
8	234°	1.107	phthalate (tentative)
9	240°	1.178	unknown
10	242°	1.200	siloxane
11	258°	1.341	siloxane
12	265°	1.478	siloxane
13	265°	1.629	siloxane
14	265°	1.661	dioctyl phthalate isomer
15	265°	1.815	siloxane
16	265°	2.065	siloxane

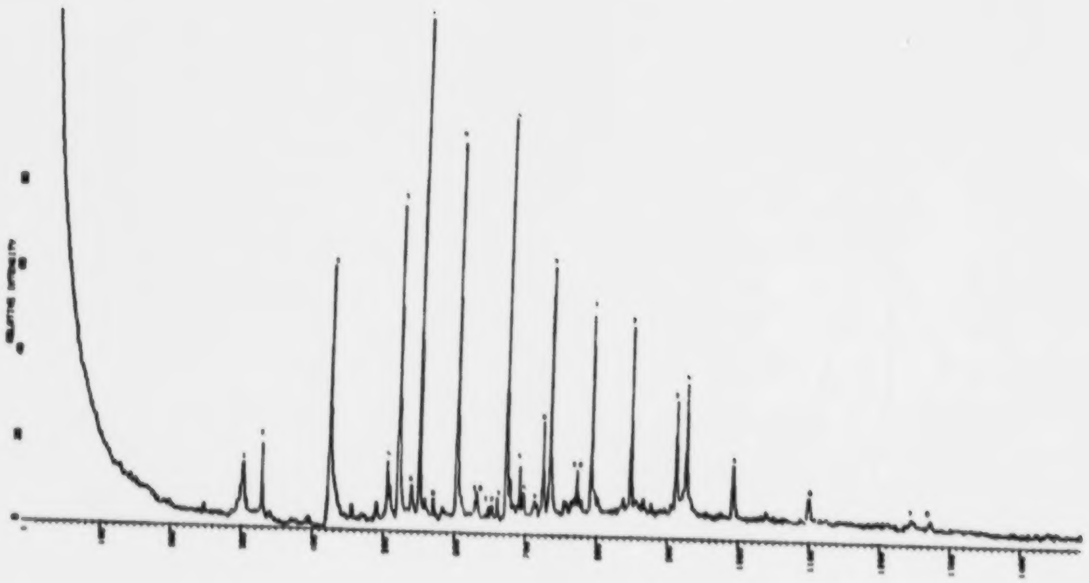

Figure H18. TIC - NPN fraction from Hi-Vol filter extract, Filter #0015.

TABLE H18. COMPOUNDS IDENTIFIED FROM NPN FRACTION, HI-VOL FILTER #0015

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	134	.477	decamethyl cyclopentasiloxane
2	141	.520	allyl butyrate
3	166	.674	siloxane
4	187	.799	2,6-ditertiary butyl-p-cresol
5	191	.821	siloxane
6	197	.853	diethylphthalate
7	199	.870	2,2,4-trimethylpenta-1,3-diol-diisobutyrate
8	207	.902	tributyl phosphate
9	213	.951	siloxane
10	220	1.000	d_{10}-anthracene (int. std.)
11	224	1.027	siloxane
12	226	1.032	siloxane
13	227	1.044	phthalate
14	231	1.062	siloxane
15	236	1.095	methyl palmitate
16	238	1.103	phthalate
17	242	1.128	siloxane
18	244	1.147	unknown
19	246	1.163	tetradecamethylhexasiloxane
20	257	1.223	bis(1,3-dimethylbutyl)adipate
21	261	1.255	tetradecamethahexasiloxane
22	265	1.342	siloxane
23	265	1.444	siloxane
24	265	1.466	bis (oct-24L)phthalate
25	265	1.572	tetradecamethylhexasiloxane
26	265	1.742	siloxane
27	265	1.965	siloxane
28	265	2.014	siloxane

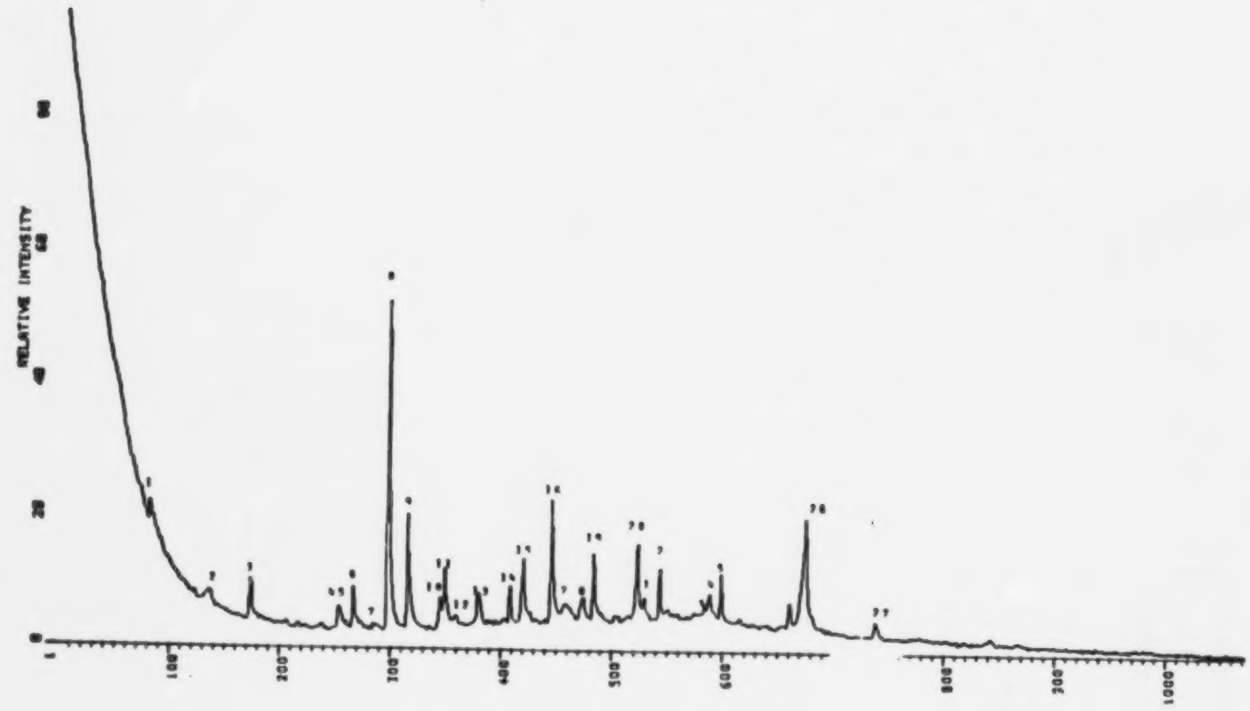

Figure H19. TIC - PNA fraction from Hi-Vol filter extract, Filter #0015.

TABLE H19. COMPOUNDS IDENTIFIED FROM PNA FRACTION, HI-VOL FILTER #0015

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	137°	.214	unknown
2	152°	.357	background
3	161°	.460	siloxane
4	182°	.669	C_9-alkylphenol
5	183°	.672	siloxane
6	185°	.704	siloxane
7	190°	.754	diethyl phthalate
8	183°	.788	2,2,4-trimethylpenta-1,3-diol diisobutyrate (bkg
9	198°	.836	tributyl phosphate
10	206°	.913	siloxane
11	207°	.923	siloxane
12	209°	.952	unknown
13	215°	1.000	d_{10}-anthracene
14	222°	1.079	dibutyl phthalate isomer
15	225°	1.111	siloxane
16	232°	1.177	dibutyl phthalate isomer
17	234°	1.209	palmitic acid (tent.)
18	239°	1.254	unknown
19	242°	1.277	siloxane
20	252°	1.376	unknown
21	254°	1.397	dibutyl sebacate (tent.)
22	257°	1.437	siloxane
23	265°	1.545	butyl benzyl phthalate
24	265°	1.556	butyl benzyl phthalate
25	265°	1.582	siloxane
26	265°	1.780	dioctyl phthalate
27	265°	1.955	siloxane

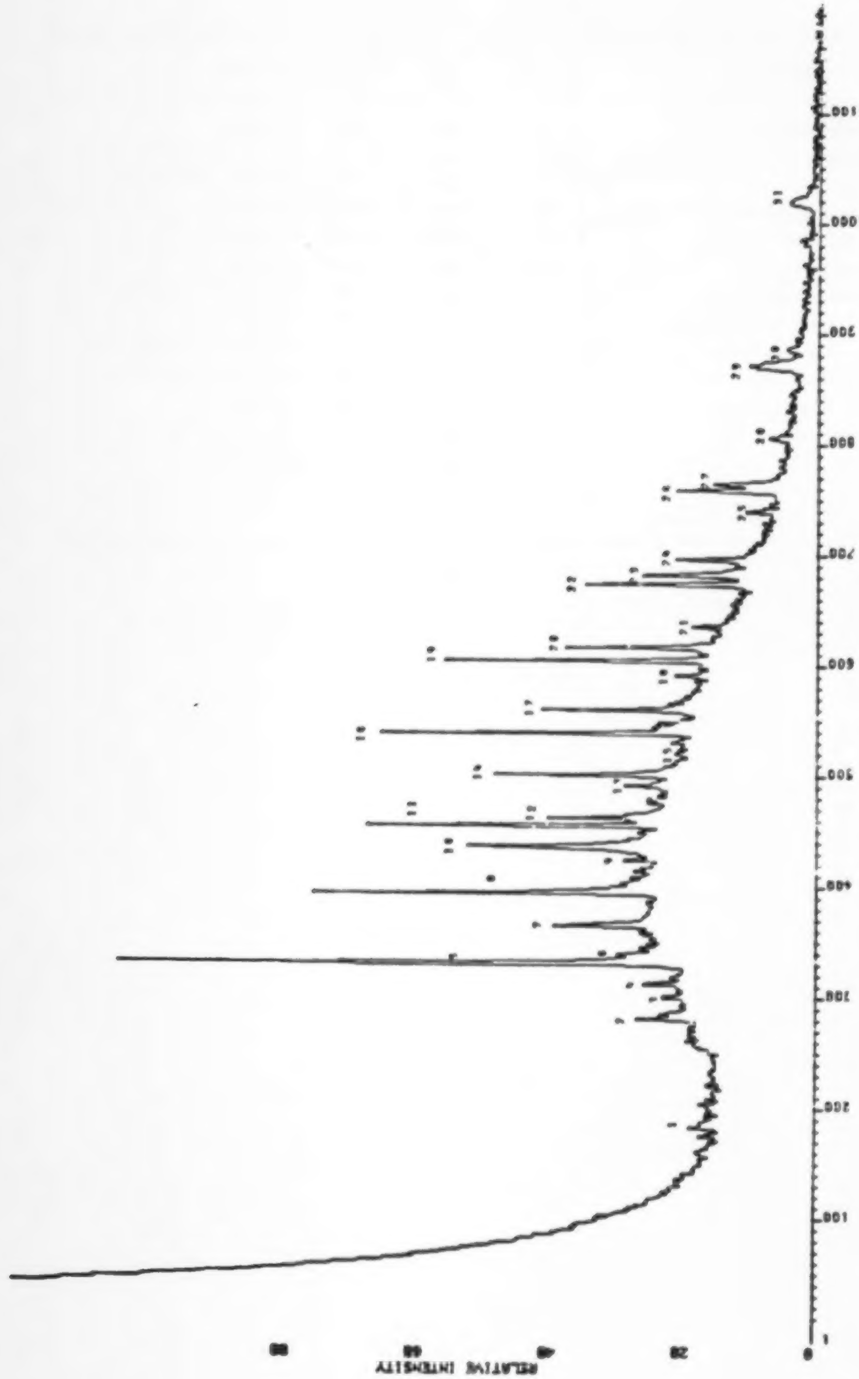

Figure H20. TIC - PN fraction from Hi-Vol filter extract, Filter #0015.

TABLE H20. COMPOUNDS IDENTIFIED FROM PN FRACTION, HI-VOL FILTER #0015

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	164°	.467	background
2	190°	.713	siloxane
3	194°	.761	diethyl phthalate
4	198°	.792	2,2,4-trimethylpenta-1,3-diol diisobutyrate (bkg)
5	202°	.843	siloxane
6	206°	.848	tributyl phosphate
7	211°	.926	siloxane
8	219°	1.000	d_{10}-anthracene (int. std.)
9	226°	1.076	dibutyl phthalate isomer
10	230°	1.109	siloxane
11	234°	1.135	siloxane
12	237°	1.173	dibutyl phthalate isomer
13	244°	1.246	unknown
14	246°	1.272	siloxane
15	251°	1.317	unknown
16	256°	1.365	siloxane
17	262°	1.421	siloxane
18	265°	1.497	unknown
19	265°	1.530	siloxane
20	265°	1.563	siloxane
21	265°	1.617	unknown
22	265°	1.708	siloxane
23	265°	1.728	siloxane
24	265°	1.764	dioctyl phthalate
25	265°	1.878	unknown
26	265°	1.924	siloxane
27	265°	1.939	siloxane
28	265°	2.048	unknown
29	265°	2.210	siloxane
30	265°	2.246	unknown
31	265°	2.588	siloxane

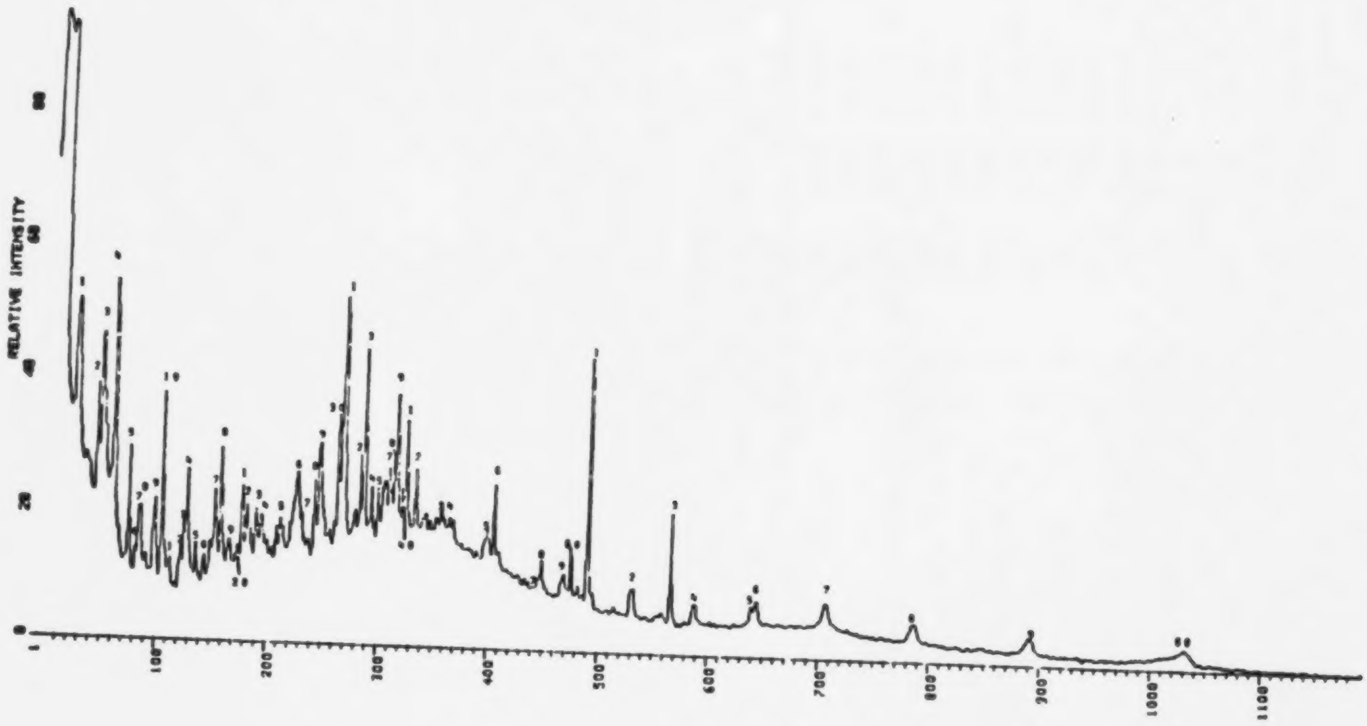

Figure H21. TIC - Acid fraction from Hi-Vol filter extract, Filter #0065.

TABLE H21. COMPOUNDS IDENTIFIED FROM ACID FRACTION, HI-VOL FILTER #0065

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	98	.154	dimethyl malonate
2	105	.282	methyl 4-oxo-pentanoate
3	106	.301	octamethylcyclo-tetrasiloxane
4	110	.378	dimethyl succinate
5	115	.474	dimethyl-methylsuccinate
6	117	.513	unsaturated hydrocarbon
7	118	.532	unsaturated hydrocarbon
8	119	.545	diethyl fumarate
9	123	.628	unsaturated hydrocarbon
10	126	.673	dimethyl glutarate
11	128	.705	unknown
12	131	.769	siloxane
13	132	.795	dimethyl-2-methyl glutarate
14	134	.821	siloxane
15	136	.865	siloxane
16	139	.917	siloxane
17	142	.962	unsaturated hydrocarbon
18	144	1.000	d_5-phenol (int. std.)
19	146	1.051	siloxane
20	149	1.103	siloxane
21	151	1.141	siloxane
22	152	1.154	siloxane
23	154	1.212	unsaturated hydrocarbon
24	155	1.237	siloxane
25	161	1.353	siloxane
26	166	1.442	siloxane
27	167	1.474	unsaturated hydrocarbon
28	170	1.551	siloxane
29	171	1.577	unsaturated hydrocarbon
30	175	1.679	phthalate
31	176	1.699	dimethyl phthalate
32	179	1.821	unknown
33	180	1.833	unknown
34	181	1.878	phthalate
35	183	1.917	siloxane
36	185	1.955	unsaturated hydrocarbon
37	186	1.981	phthalate
38	187	1.994	methyl laurate
39	189	2.019	dimethyl azelate (tentative)
40	190	2.058	phthalate
41	192	2.077	diethyl terephthalate (tentative)
42	194	2.135	diethyl phthalate
43	200	2.288	phthalate
44	202	2.353	di-tert-butylphenol isomer (tent)
45	211	2.551	siloxane
46	212	2.590	methyl tetradecanoate
47	222	2.858	octamethyl trisiloxane
48	223	2.872	methyl pentadecanoate
49	228	3.000	siloxane
50	230	3.032	siloxane
51	234	3.135	methyl palmitate
52	244	3.391	siloxane
53	253	3.628	methyl stearate
54	259	3.769	siloxane
55	265	4.096	siloxane
56	265	4.122	siloxane
57	265	4.519	siloxane
58	265	5.019	siloxane
59	265	5.699	siloxane
60	265	6.603	siloxane

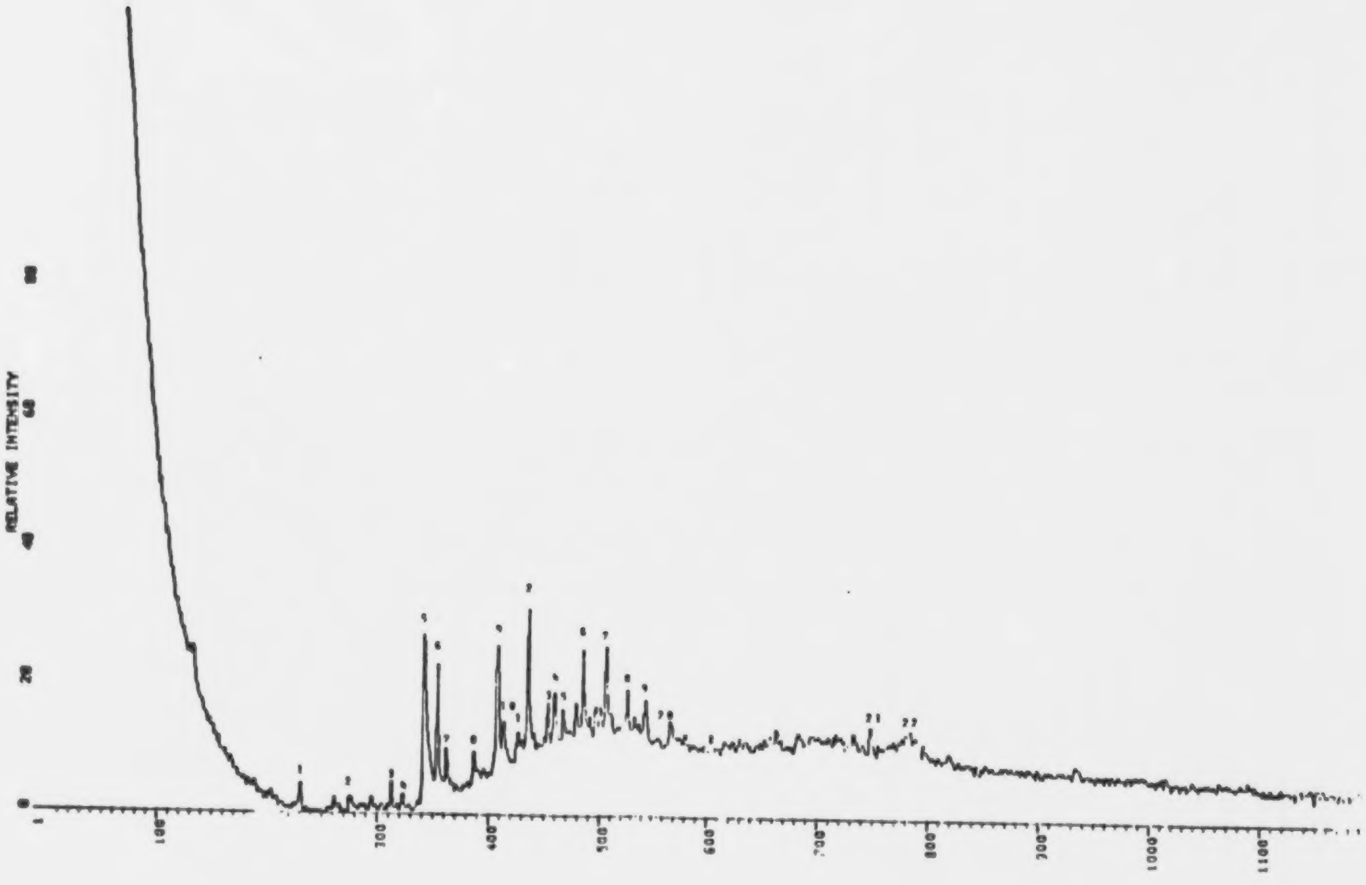

Figure H22. TIC - Base fraction from Hi-ol filter extract, Filter #0065.

TABLE H22. COMPOUNDS IDENTIFIED FROM BASE FRACTION, HI-VOL FILTER #0065

Chromatographic Peak No.	Elution Temp. (°C)	Compound	Chromatographic Peak No.	Elution Temp. (°C)	Compound
1	167	siloxane	12	220	siloxane
2	179	dimethyl phthalate	13	225	unsaturated hydrocarbon
3	189	unsaturated hydrocarbon	14	226	unsaturated hydrocarbon
4	191	siloxane	15	228	phthalate
5	196	diethyl phthalate	16	233	siloxane
6	199	2,2,4-trimethyl penta-1,3-diol di-isobutyrate	17	238	phthalate
			18	243	siloxane
7	201	$C_{16}H_{34}$ isomer	19	245	siloxane
8	209	unsaturated hydrocarbon	20	248	alkyl indan (tentative)
9	213	1,1,3-trimethyl-3-phenyl indane	21	265	siloxane
10	214	unsaturated hydrocarbon	22	265	siloxane
11	218	unknown			

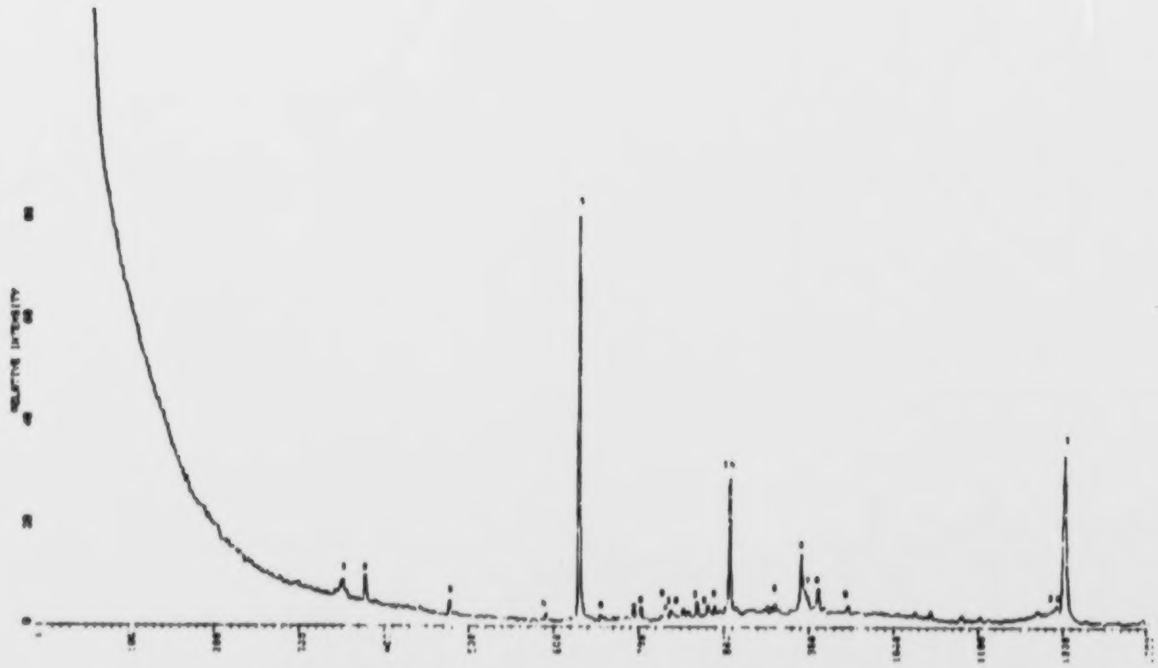

Figure H23. TIC - NPN fraction from Hi-Vol filter extract, Filter 0065.

TABLE H23. COMPOUNDS IDENTIFIED FROM NPN FRACTION, HI-VOL FILTER #0065

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	137	.474	siloxane
2	144	.512	dodecane
3	169	.647	siloxane
4	199	.802	siloxane
5	208	.852	2,2,4-trimethyl penta-1,3-diol di-isobutyrate
6	215	.889	tri-butyl phosphate
7	225	.940	siloxane
8	227	.953	methyl decanoate
9	235	.992	siloxane
10	238	1.000	d_{10}-anthracene (int. std.)
11	244	1.041	siloxane
12	248	1.060	siloxane
13	250	1.071	siloxane
14	254	1.095	methyl palmitate
15	265	1.168	siloxane
16	265	1.209	saturated hydrocarbon
17	265	1.218	unknown
18	265	1.235	methyl stearate
19	265	1.284	siloxane
20	265	1.615	phthalate
21	265	1.632	di-*n*-octyl phthalate

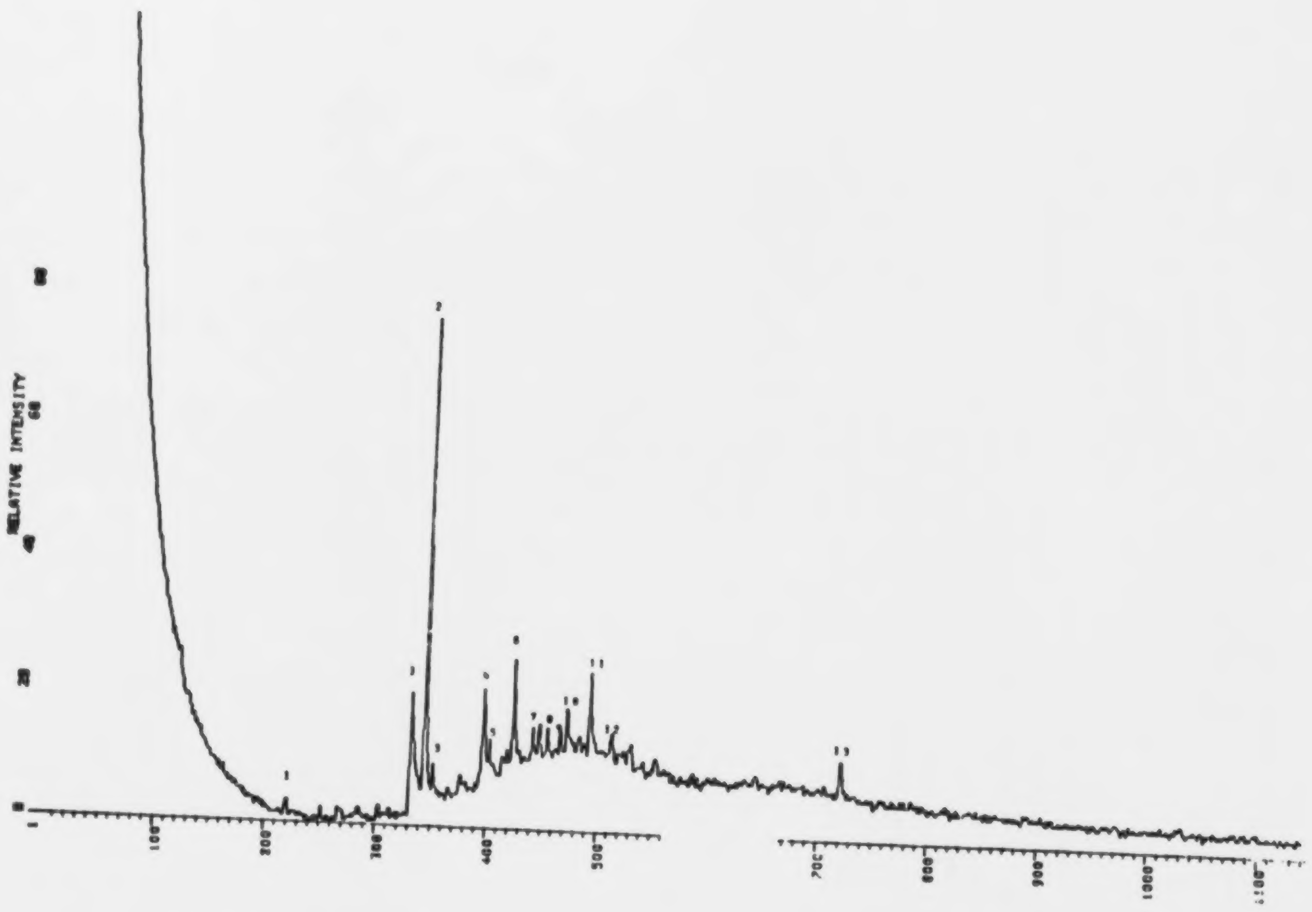

Figure H24. TIC - PNA fraction from Hi-Vol filter extract, Filter #0065.

TABLE H24. COMPOUNDS IDENTIFIED FROM PNA FRACTION, HI-VOL FILTER #0065

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	192	.708	diethyl phthalate
2	196	.736	2,2,4-trimethyl penta-1,3-diol di-isobutyrate
3	202	.755	siloxane
4	209	.850	trimethyl-phenyl-indane isomer
5	211	.865	saturated hydrocarbon
6	216	.908	siloxane
7	221	.946	saturated hydrocarbon
8	224	.974	phthalate
9	227	1.000	d_{10}-anthracene (int. std.)
10	229	1.011	siloxane
11	234	1.054	phthalate
12	239	1.097	$C_{19}H_{14}$ isomer (methylbenzo-phenanthrene, methylbenz-anthracene, methylchrysene, or methyl-triphenylene)
13	265	1.545	siloxane

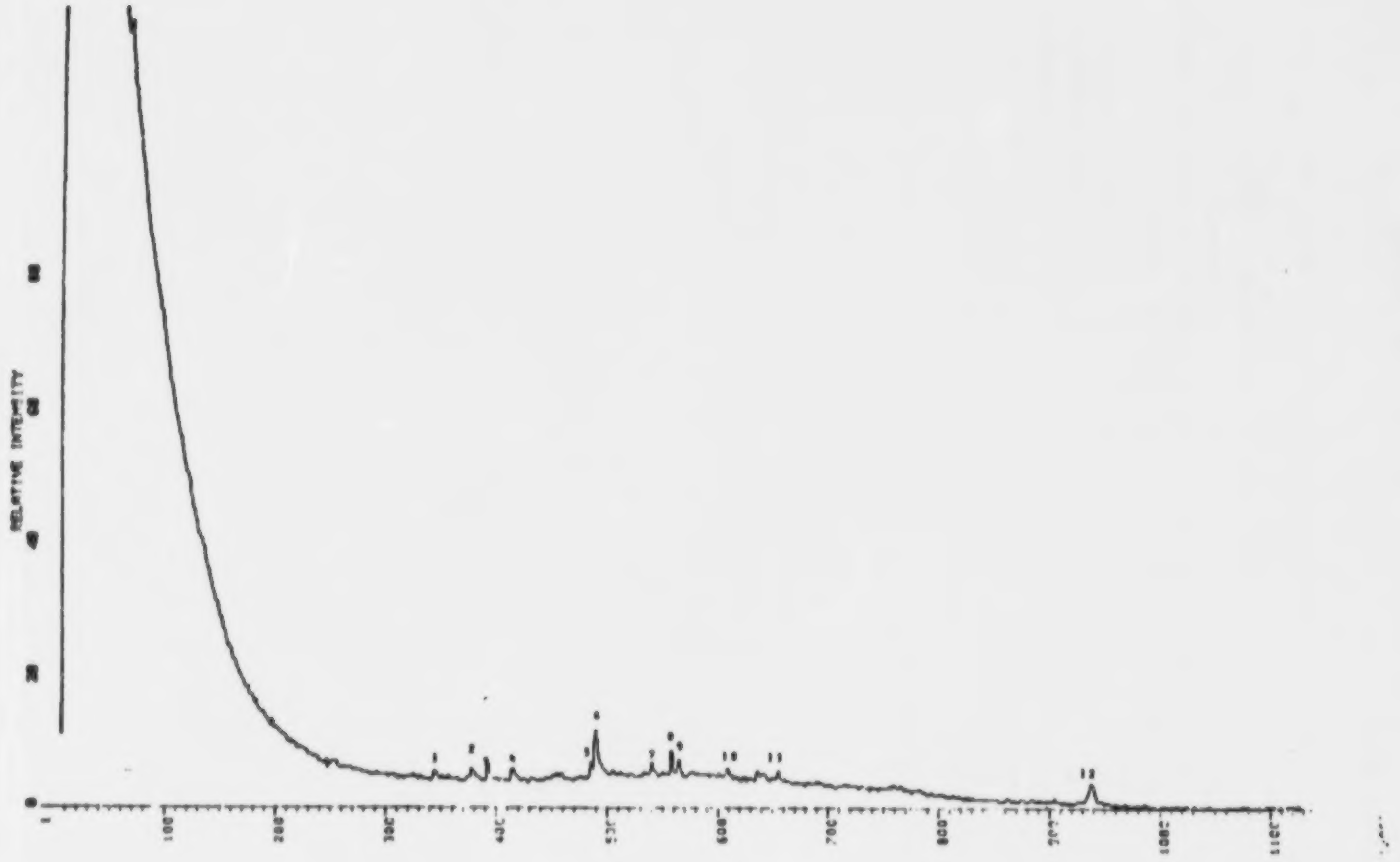

Figure H25. TIC - PN fraction from Hi-Vol filter extract, Filter #0065.

TABLE H25. COMPOUNDS IDENTIFIED FROM PN FRACTION, HI-VOL FILTER #0065

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	197	.705	unsaturated hydrocarbon
2	206	.773	diethyl phthalate
3	209	.799	2,2,4-trimethyl penta-1,3-diol di-isobutyrate
4	215	.848	tributyl phosphate
5	233	.994	siloxane
6	234	1.000	d_{10} -anthracene (int. std.)
7	247	1.107	siloxane
8	252	1.141	methyl palmitate
9	253	1.156	phthalate
10	264	1.248	siloxane
11	265	1.316	alkyl indan (tentative0
12	265	1.920	di-n-octyl phthalate

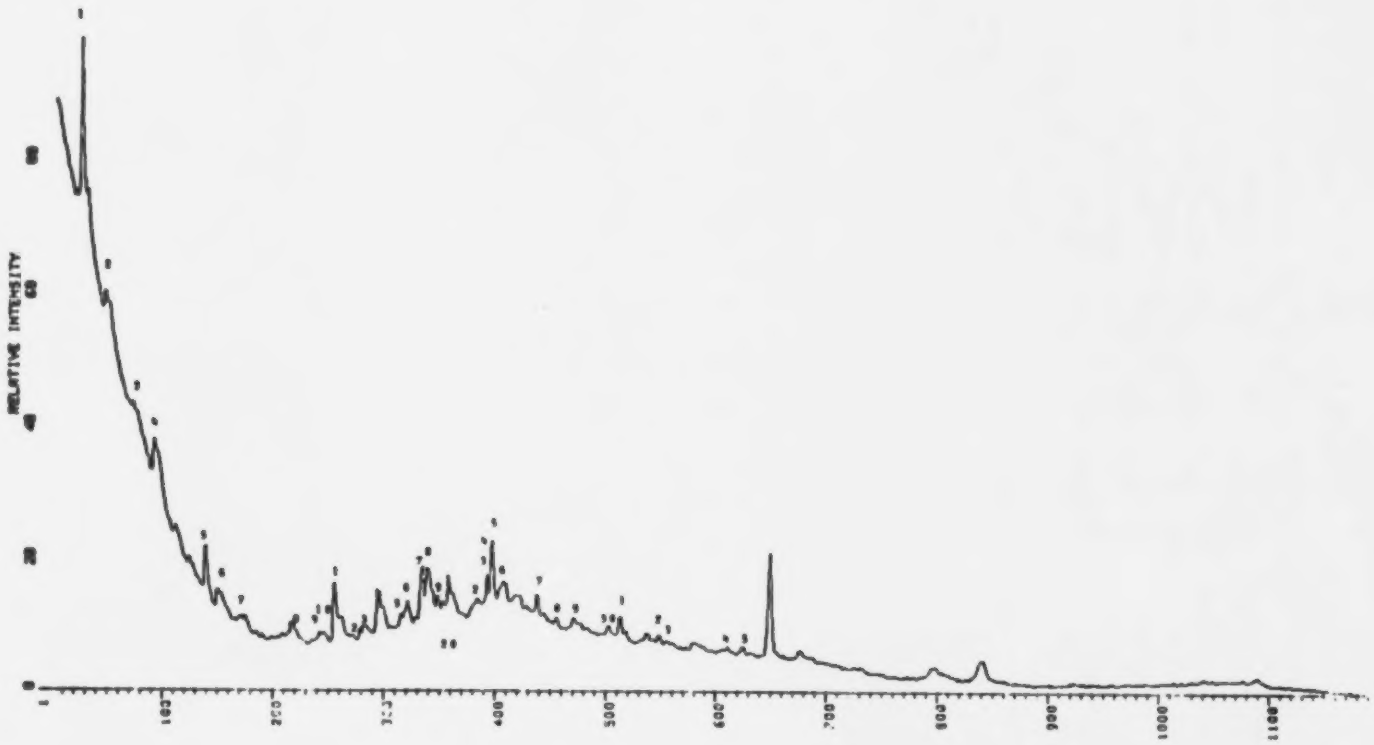

Figure H26. TIC - Acid fraction from Hi-Vol filter extract, Filter #0066.

TABLE H26. COMPOUNDS IDENTIFIED FROM ACID FRACTION, HI-VOL FILTER #0066

Chromato-graphic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	114	.325	dimethyl sulfate
2	119	.610	dimethyl malonate
3	125	1.000	d_5-phenol (int. std.)
4	129	1.195	dimethyl succinate
5	140	1.805	unsaturated hydrocarbon
6	142	1.948	unsaturated hydrocarbon
7	147	2.260	methoxythiazole (tentative)
8	157	2.831	unsaturated hydrocarbon
9	162	3.117	unsaturated hydrocarbon
10	164	3.195	unsaturated hydrocarbon
11	166	3.299	phthalic anhydride
12	171	3.610	methyl heptanoate (tentative)
13	172	3.649	unsaturated hydrocarbon
14	175	3.818	unsaturated hydrocarbon
15	180	4.104	dimethyl-benzofuranone isomer (tentative
16	181	4.156	unsaturated hydrocarbon
17	183	4.312	benzofuran (tentative)
18	185	4.403	unsaturated hydrocarbon
19	186	4.468	dimethyl phthalate
20	187	4.519	unsaturated hydrocarbon
21	190	4.701	unsaturated hydrocarbon
22	195	4.987	unsaturated hydrocarbon
23	196	5.039	alkyl indan (tentative)
24	197	5.091	methyl laurate
25	198	5.143	methyl nonane-dioate isomer (tentative)
26	200	5.260	unsaturated hydrocarbon
27	207	5.675	2,2,4-trimethyl penta-1,3-diol di-isobutyrate
28	209	5.766	phthalate
29	215	6.130	unsaturated hydrocarbon
30	222	6.545	alkyl benzene (tentative)
31	224	6.649	methyl tetradecanoate
32	232	7.117	siloxane
33	234	7.195	$C_{14}H_{10}$ isomer (phenanthrene, diphenyl acetylene or anthracene) (tentative)
34	246	7.935	siloxane
35	249	8.018	siloxane

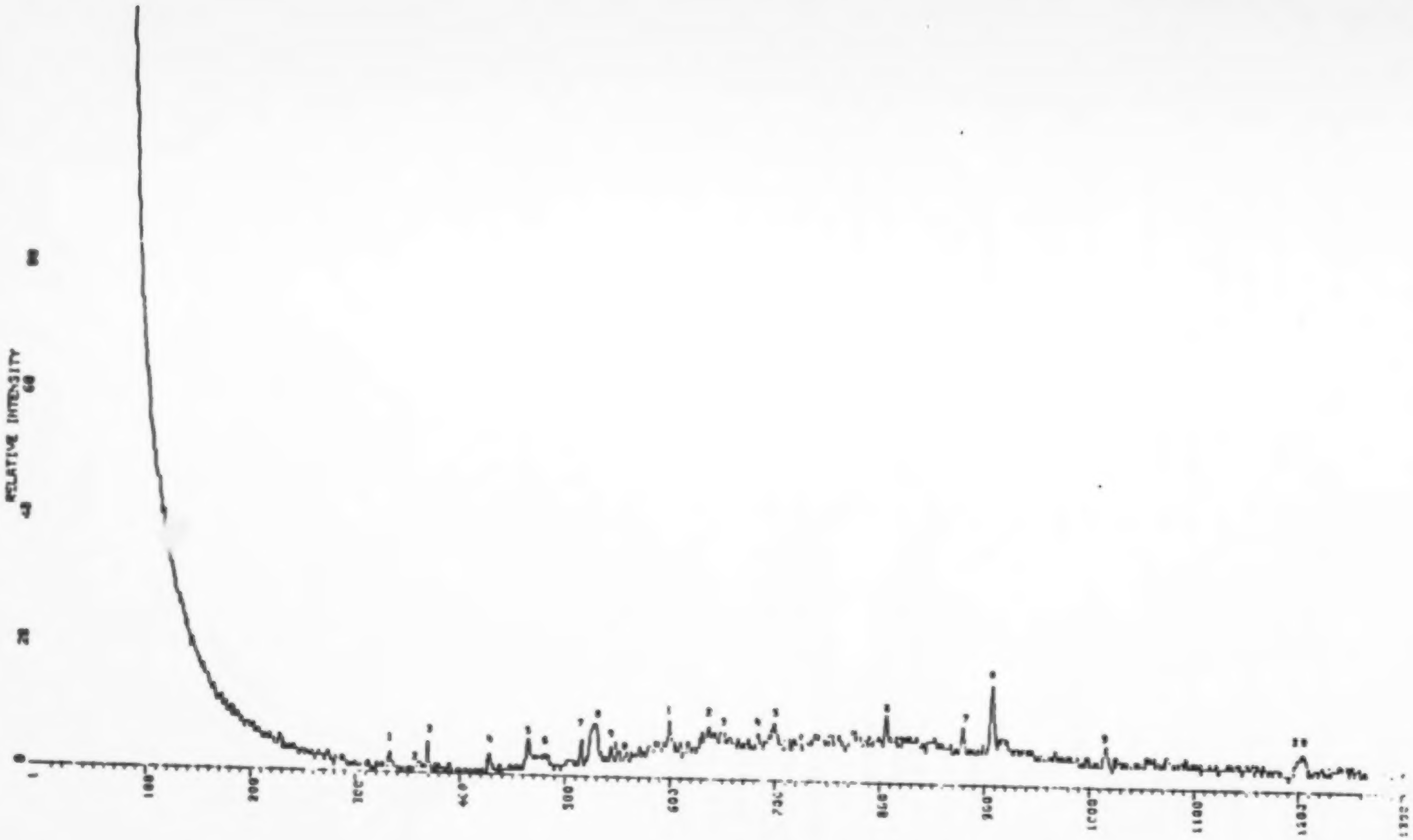

Figure H27. TIC - Base fraction from Hi-Vol filter extract, Filter #0066.

TABLE H27. COMPOUNDS IDENTIFIED FROM BASE FRACTION, HI-VOL FILTER #0066

Chromato-graphic Peak No.	Elution Temp. (°C)	Compound
1	194	siloxane
2	200	dimethoxy benzaldehyde isomer (tent.)
3	204	2,2,4-trimethyl penta-1,3-diol di-isobutyrate
4	219	siloxane
5	229	$C_{14}H_{10}$ isomer (anthracene, phenanthrene, or diphenyl acetylene)
6	233	$C_{14}H_{10}$ isomer (tentative)
7	242	siloxane
8	245	di-2-ethylhexyl phthalate
9	249	methylene phenanthrene (tentative)
10	251	phthalate
11	264	unsaturated hydrocarbon
12	265	unsaturated hydrocarbon
13	265	unsaturated hydrocarbon
14	265	siloxane
15	265	siloxane
16	265	alkyl quinoline (tentative)
17	265	phthalate
18	265	di-*n*-octyl phthalate
19	265	siloxane
20	265	siloxane

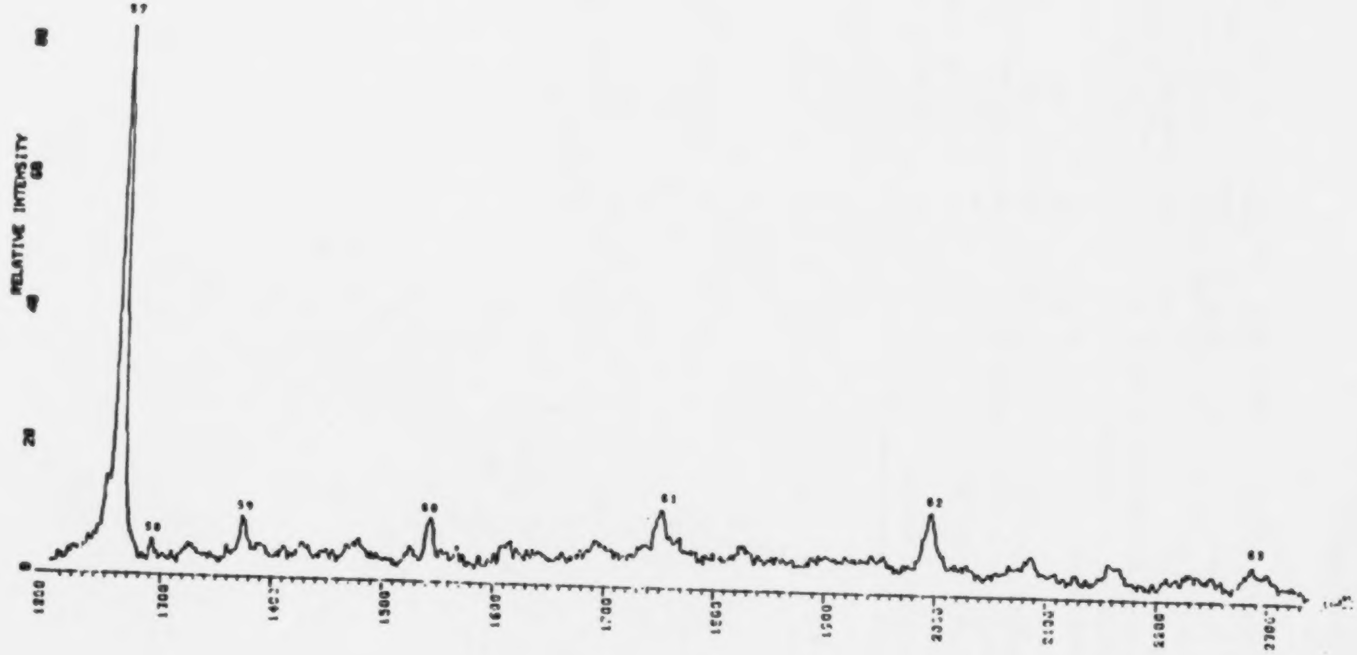

Figure H28. TIC - NPN fraction from Hi-Vol filter extract, Filter #0066.

TABLE H28. COMPOUNDS IDENTIFIED FROM NPN FRACTION, HI-VOL FILTER #0066

Chromatographic Peak No.	Elution Temp. (°C)	Compound
1	110	saturated hydrocarbon
2	111	saturated hydrocarbon (tentative)
3	112	saturated hydrocarbon
4	118	$C_{11}H_{14}$ isomer
5	120	phthalate
6	121	$C_{12}H_{26}$ isomer (n-dodecane)
7	123	$C_{12}H_{26}$ isomer
8	124	dimethyl-cyclohexane (tentative)
9	125	$C_{12}H_{26}$ isomer
10	127	$C_{12}H_{24}$ isomer (trans dimethyl trans isobutylcyclohexane)
11	128	unsaturated hydrocarbon
12	129	$C_{12}H_{26}$ isomer
13	130	naphthalene
14	131	saturated hydrocarbon
15	132	saturated hydrocarbon
16	137	$C_{12}H_{26}$ isomer (n-dodecane)
17	141	$C_{13}H_{28}$ isomer
18	150	methylnaphthalene isomer
19	160	siloxane
20	163	$C_{12}H_{10}$ isomer (diphenyl, acenaphthene, or phenylbenzene) (tentative)
21	167	dimethylnaphthalene isomer
22	169	ethylnaphthalene isomer
23	173	$C_{12}H_8$ isomer (biphenylene)(tentative)
24	178	$C_{12}H_{10}$ isomer (diphenyl, acenaphthene, of phenylbenzene) (tentative)
25	184	unsaturated hydrocarbon
26	184	methyl laurate
27	186	siloxane
28	192	phthalate
29	193	fluorene (tentative)
30	195	2,2,4-trimethyl penta-1,3-diol di-isobutyrate
31	209	siloxane
32	210	$C_{17}H_{36}$ isomer
33	211	methyl tetradecanoate
34	216	phthalate
35	218	siloxane
36	218	$C_{14}H_{10}$ isomer (antracene, phenantrene, or diphenylacetylene)
37	222	$C_{18}H_{38}$ isomer
38	223	unsaturated hydrocarbon
39	225	unsaturated hydrocarbon
40	229	siloxane
41	235	$C_{17}H_{34}O_2$ isomer (methyl palmitate, 1,4-methylpentadeconate)
42	239	$C_{16}H_{32}O_2$ isomer (methyl methyltetradeconate)
43	245	$C_{20}H_{42}$ isomer
44	247	siloxane
45	252	$C_{16}H_{10}$ isomer (diphenyl diacetylene, pyrene, or fluoranthrene)
46	254	$C_{19}H_{34}O_2$ isomer
47	259	$C_{19}H_{38}O_2$ isomer
48	261	$C_{16}H_{10}$ isomer
49	264	dinaphthothiopene (tentative)
50	265	siloxane
51	265	$C_{22}H_{46}$ isomer
52	265	$C_{17}H_{12}$ isomer (methylpyrene) (tentative)
53	265	$C_{23}H_{48}$ isomer
54	265	siloxane
55	265	unsaturated hydrocarbon
56	265	$C_{24}H_{50}$ isomer
57	265	di-n-octyl phthalate
58	265	saturated hydrocarbon
59	265	$C_{26}H_{54}$ isomer
60	265	$C_{27}H_{56}$ isomer
61	265	$C_{28}H_{58}$ isomer
62	265	$C_{29}H_{60}$ isomer
63	265	$C_{30}H_{62}$ isomer

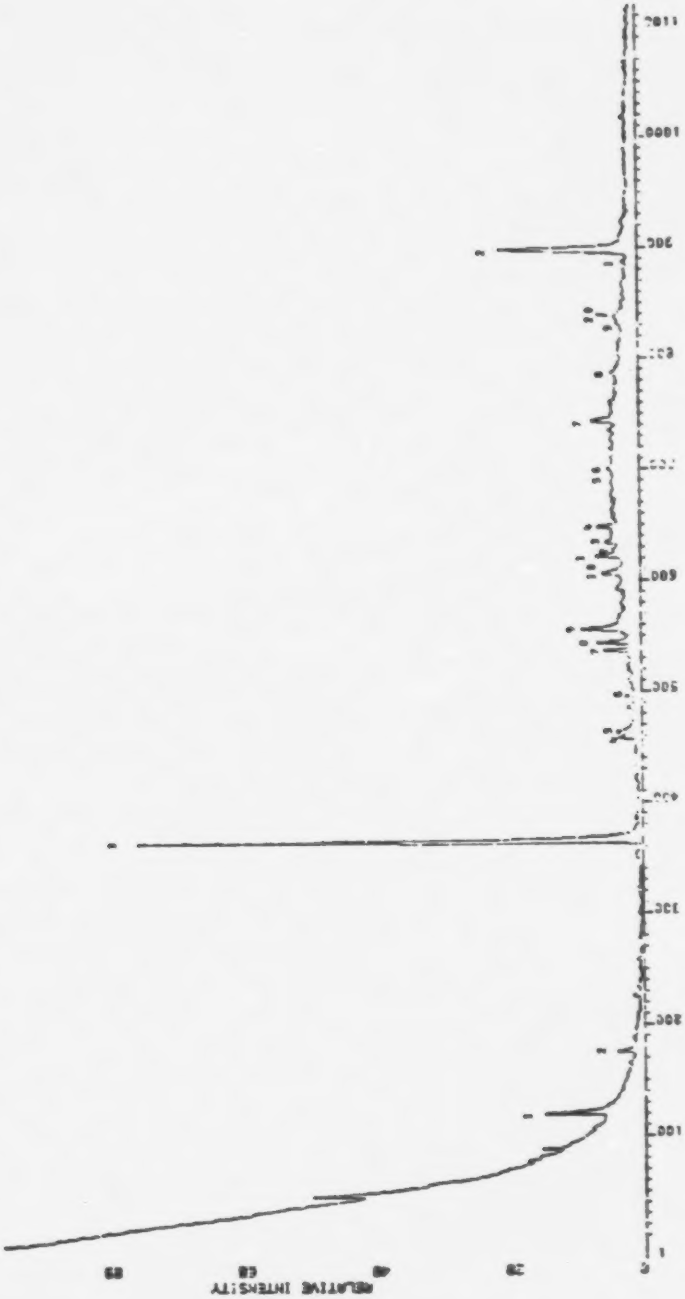

Figure H29. TIC - PNA fraction from Hi-Vol filter extract, Filter #0066.

TABLE H29. COMPOUNDS IDENTIFIED FROM PNA FRACTION, HI-VOL FILTER #0066

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	139	.260	neopentyl glycol (tentative)
2	153	.379	unsaturated hydrocarbon
3	201	.786	2,2,4-trimethyl penta-1,3-diol di-isobutyrate
4	226	.991	$C_{14}H_{10}$ isomer (anthracene, phenanthrene, or diphenyl acetylene)
5	227	1.000	d_{10}-anthracene (int. std.)
6	235	1.074	phthalate
7	246	1.160	methyl palmitate
8	248	1.175	phthalate
9	251	1.206	$C_{17}H_{36}O$ isomer
10	264	1.307	$C_{16}H_{10}$ isomer (pyrene, fluoranthene, or diphenyldiacetylene)
11	265	1.344	unsaturated hydrocarbon
12	265	1.357	indene (tentative)
13	265	1.370	$C_{16}H_{10}$ isomer
14	265	1.400	unknown
15	265	1.487	$C_{17}H_{12}$ isomer (methylpyrene, or benzofluorene)
16	265	1.509	$C_{17}H_{12}$ isomer
17	265	1.608	butylbenzyl phthalate
18	265	1.701	unsaturated hydrocarbon
19	265	1.799	$C_{18}H_{12}$ isomer (chrysene, naphthacene, triphenylene or benz-anthracene)
20	265	1.810	$C_{18}H_{12}$ isomer
21	265	1.920	phthalate
22	265	1.944	di-n-octyl phthalate

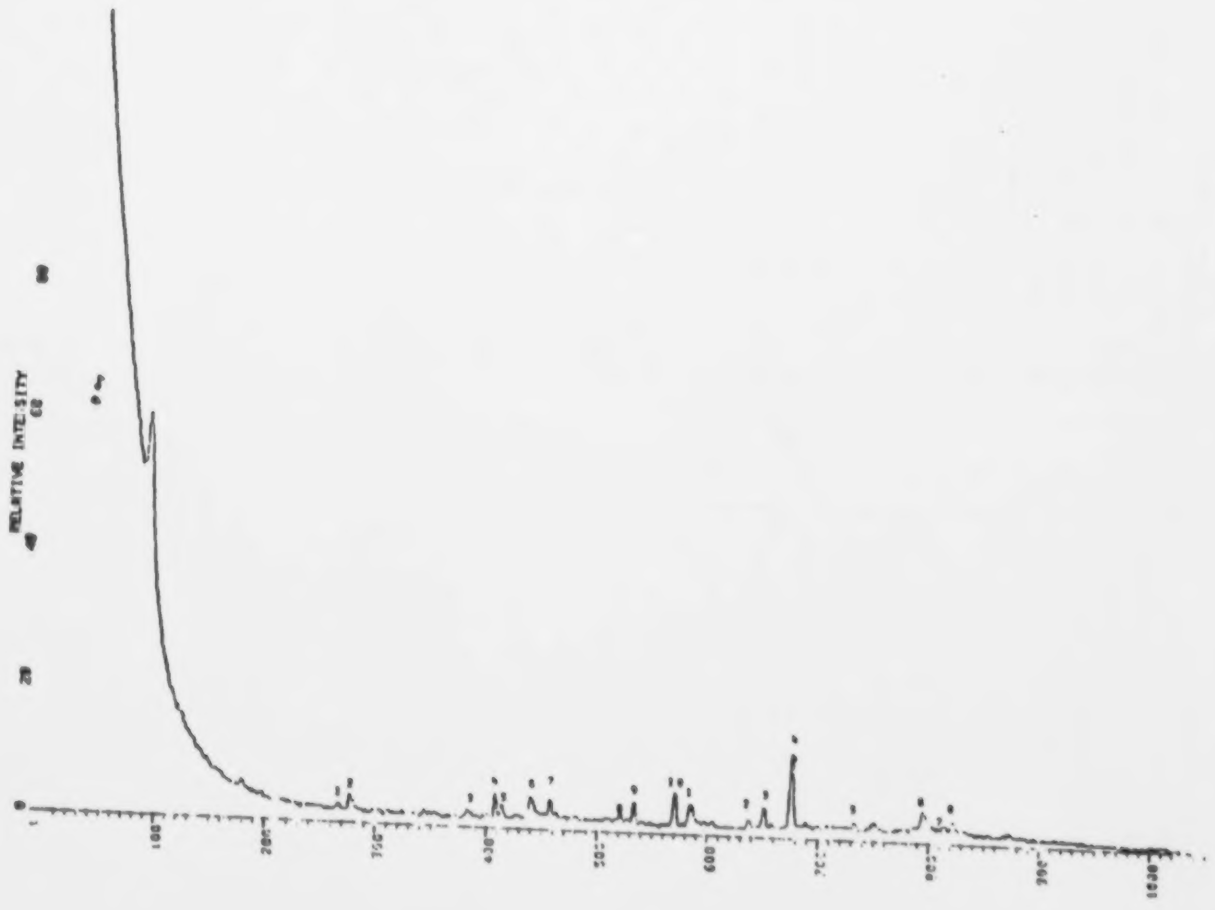

Figure H30. TIC - PN fraction from Hi-Vol filter extract, Filter #0066.

TABLE H30. COMPOUNDS IDENTIFIED FROM PN FRACTION, HI-VOL FILTER #0066

Chromatographic Peak No.	Elution Temp. (°C)	Relative Retention Time	Compound
1	169	.436	siloxane
2	171	.473	methyl caprate
3	199	.654	unsaturated hydrocarbon
4	205	.695	methyl laurate
5	207	.707	siloxane
6	213	.751	phenyl-methyl-hexanone isomer (tentative)
7	218	.782	2,2,4-trimethyl penta-1,3-diol di-isobutyrate
8	224	.892	siloxane
9	237	.913	methyl tetradecanoate
10	247	.974	siloxane
11	250	1.000	d_{10}-anthracene (int. std.)
12	264	1.093	siloxane
13	265	1.113	siloxane
14	265	1.156	methyl palmitate
15	265	1.256	unsaturated hydrocarbon
16	265	1.360	siloxane
17	265	1.391	alkyl indan (tentative)
18	265	1.408	methyl stearate